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Straw-bale passive house plus, Leyburn
Photo by Paul White

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editor's letter

ISSUE 22

Nearly two months have elapsed since the tragic events of 14 June, but what else is there for me to write about other than Grenfell Tower? I, like so many people, spent the first few weeks after the disaster reeling – a disaster in which 80 innocent men, women and children needlessly saw their lives ended. The feeling was palpable – a heaviness and bereftness which evoked the sensation of grieving over the death of a loved one. And although it still feels impossibly hard to write about, I am duty bound to try.

Allow me this banal truth: this tragedy should never have been allowed to happen, and must never be repeated. Each one of the multitude of potential contributory factors must be determined and analysed, and we must learn and apply the appropriate lessons, however much difficulty that causes. There is much ground to cover. There's the use of a polyethylene-filled rainscreen cladding system and insufficiently fire-resistant insulation on such a tall building – when the building regulations are supposed to require "limited combustibility" for materials used on buildings that go above 18 metres. There's the matter of whether the fire barriers were installed correctly and consistently. There's the incomplete works on exposed gas pipes. There's the nebulous issue of the flexibility afforded to the industry in determining how to comply with building regulations. And then, among many other issues, there's the question of accountability, whether that relates to the political ideologues who ignored the risk to people's lives inherent in their idiotic mantra of cutting red tape, or the designers, contractors, suppliers, certifiers and, yes, construction journalists who all have roles to play in ensuring that buildings do not threaten but instead protect and enhance the lives of the occupants they contain.

But while we must act decisively, we must avoid knee jerk reactions, which could do more harm than good. There has been much speculation that an immediate consequence of Grenfell will be to put a stop to retrofitting of buildings. Such a decision could have disastrous effects. BBC Panorama reported last year that fuel poverty caused an estimated 9,000 of the 44,000 excess winter deaths in the UK in the winter of 2014-15. A 2016 Royal College of Physicians report stated that "The annual morality burden in the UK from exposure to outdoor air pollution is equivalent to around 40,000 deaths." And without due care, outdoor air pollution becomes indoor air pollution, leading to calls from housing experts to mandate airtightness and filtered mechanical ventilation for buildings in more polluted areas – though it goes without saying that we must prevent that pollution from occurring too. Throw the increasingly manifest impacts of climate change into the mix and you have excess summer mortality risks, exacerbated by our almost total ignorance of the growing threat posed by overheating – a threat that's bound to rise considerably within the lifespan of the buildings the industry is working on today. And don't forget the hard-to-comprehend but vast threat that our collective failure to sufficiently tackle climate change poses to the lives of billions of people around the world over the coming decades. We run the very real risk of making some of the most populous regions of the world uninhabitable.

The challenges we face may seem impossibly hard, but we have little choice. We must all strive to build robust, safe, healthy buildings that protect and in fact enhance the lives of the people they contain – as well as the lives of billions of people in current and future generations around the world to whom we share a collective responsibility.

Regards,
The editor

About
Passive House Plus is an official partner magazine of The Association for Environment Conscious Building, The International Passive House Assocation and The Passivehaus Trust.

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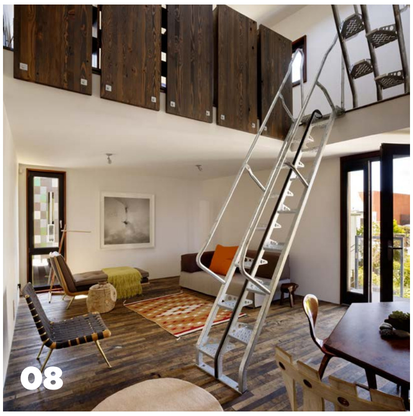

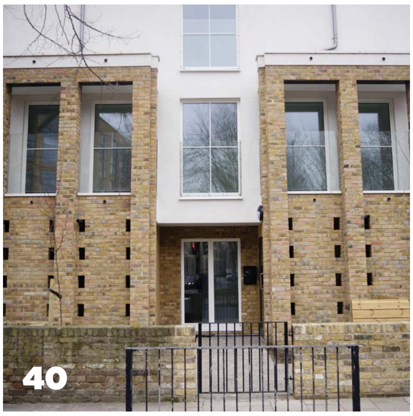
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GRENFELL TOWER:

the end of high rise retrofit?

The tragic Grenfell Tower fire should never have been allowed to occur. Dr Peter Rickaby outlines some of the key questions that now must be asked to ensure such events are never repeated.

On 13 June, in a conference address about retrofit policy, I suggested that the UK retrofit industry is dangerously incompetent, and that is why we need to implement the Each Home Counts review. Little did I know that in less than twenty-four hours those words would come back to haunt me in the most horrific way. The Grenfell Tower fire in Kensington has changed the UK retrofit industry forever. Two days later, driving to another retrofit conference, I had to stop the car because a radio news report of children returning to their school to discover which of their classmates were dead or missing, was too upsetting. As I write this I am still angry about an avoidable tragedy that, like all such events, is born of incompetence, complacency and carelessness.

We should not pre-judge the outcome of the public inquiry, but from the news reports and videos, and internet searches, we can discern that a fire in a fourth-floor flat was not contained by the compartmentation but spread around and up the outside of the building through the recently installed external insulated cladding. The fire safety instructions to residents advised them to stay in their flats because any fire should be contained by the compartmentation until extinguished. Many did stay, and died, because the advice had not been updated to take account of the risk of fire spread via the new cladding. There was no sprinkler system and only one stairway, which quickly filled with smoke.

The insulated external cladding consisted of combustible polyisocyanurate (PIR) insulation boards and combustible aluminium-plastic composite rain-screen cladding panels. The fire spread rapidly behind the cladding until the building was engulfed in flame, the insulation burned and melting panels fell on to escaping residents and rescuers. Whether fire stops were installed in the cladding, and if so why they were not effective, is not yet known.

The recent retrofit is claimed to have complied with building regulations, but full plans and specifications were not deposited with a building control body. Instead, a building notice was issued – a less expensive and quicker, but legal procedure that is inappropriate to a project of this size and complexity, because it reduces opportunity for technical scrutiny. No doubt the compliance of many aspects of the work was also self-certified by members of so-called 'competent persons schemes' that have been approved by the UK government to reduce the public cost of building control. Very few developed countries allow such self-certification, which has already been implicated in several retrofit failures.

The Grenfell Tower disaster raises hundreds of questions to which the surviving residents and the residents of other, similar blocks are entitled to answers. Not least is how can such an event happen in the richest borough of one of the world's greatest cities, in the twenty-first century? Here are the other questions that I want the public inquiry to answer:

- Why was Grenfell Tower insulated with combustible PIR board instead of incombustible mineral-fibre insulation? Building regulations require cladding on the outside of buildings over 18 metres high to be incombustible.
- Why were the cheapest plastic-aluminium composite rain-screen cladding panels used, instead of slightly more expensive but fire-resisting ones?
- Were fire stops correctly installed in the cladding? If no, why not? If yes, why weren't they effective?
- Why wasn't a sprinkler system installed, as would have been required in a new high-rise residential building, and as recommended by a coroner after a similar fatal fire in another residential block, a few years ago?
- Why wasn't the escape stairway pressurised to keep smoke out as soon as the fire alarm was activated? This technique has been common in public buildings for at least forty years.
- Why weren't the fire safety instructions updated to take account of the changed risk, after the retrofit, and why did the fire service continue to advise residents to stay in their flats for two hours after the first alarm?
- Was the compliance of any of the retrofit work self-certified under competent persons schemes, and if so did it comply?
- Why has the UK government so enthusiastically rolled out competent persons schemes for demonstrating compliance with building regulations, in the face of evidence that they are ineffective?
- Why have social housing organisations been starved of funds to invest in their housing stocks by cuts and by government-imposed rent reductions of one percent per year for four years?
- Why has the regulator, the Homes and Communities Agency (HCA), not approved housing organisations borrowing to invest in their existing stocks, and only supported borrowing in pursuit of the government's policy of building as much new housing as possible?
- Why are new high-rise residential blocks, which are springing up across London, built to current standards (including sprinklers), while existing social housing is neglected?

The Grenfell Tower fire will almost certainly mark the end of plastic-foam external wall insulation on high-rise buildings, probably on any building. It may mark the end of any external wall insulation on residential towers, leaving us little option but to leave residents in cold, hard-to-heat, mouldy homes, or to demolish and rebuild. It may delay retrofit in social housing for a while, because scarce resources will be diverted to improving fire safety and installing sprinkler systems. The social, economic and environmental repercussions will last for many years. ■

Peter Rickaby is director of Rickaby Thompson Associates, a trustee of the National Energy Foundation, a member of the Each Home Counts Implementation Board and chairs the BSI Retrofit Standards Task Group. The views expressed in this column are his own.


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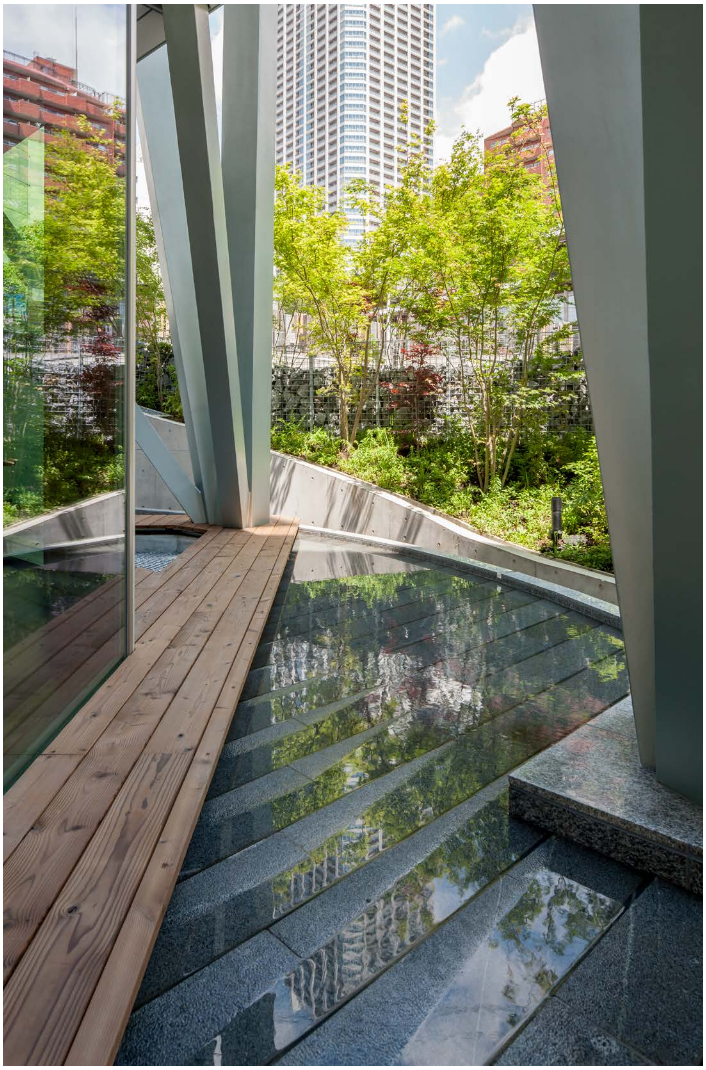


BUNYUKAKU PAVILION, TOCHOJI TEMPLE, JAPAN

Japan is famed for its countless Buddhist temples, and the Bunyukaku pavilion at the Tochoji Temple in Shinjuku-ku, Tokyo is the first piece of Buddhist architecture in the world that explicitly aimed to meet the passive house standard. Unfortunately, it didn't succeed.

Built with a steel frame and featuring four seismic isolation systems — essential in the earthquake-prone Japanese capital — the building simply has too many thermal bridges (points where heat can pass through the insulation layer) to meet the passive house standard's space heating targets.

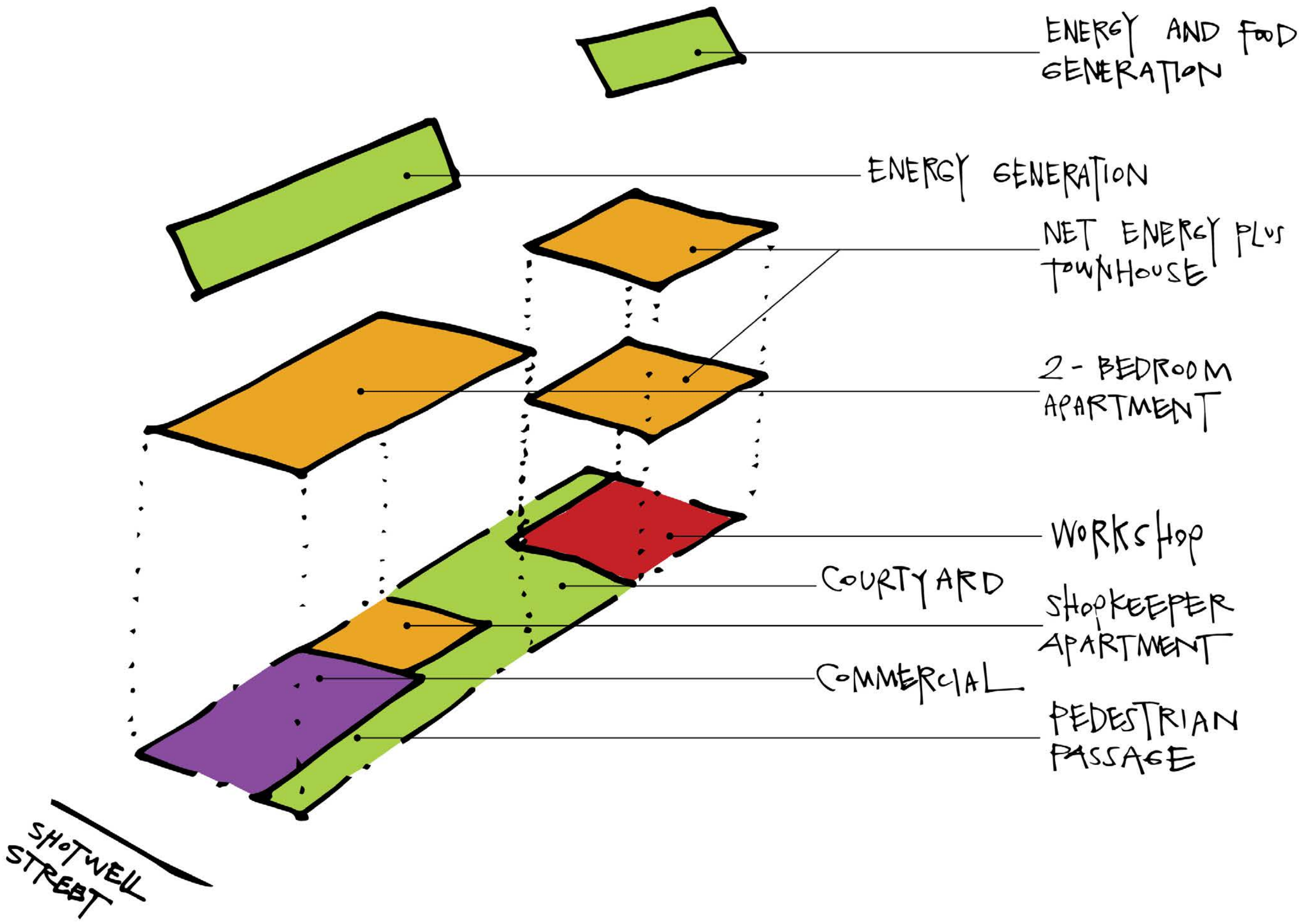
It did, however, meet the Passive House Institute's new and less onerous 'low energy building standard', which was introduced for projects that cannot, for various reasons, meet the full standard.

Designed by Miwa Mori of Key Architects, the pavilion also scored an excellent airtightness test result of 0.38 air changes per hour. It features a geothermal system for heating and cooling, plus two Mitsubishi ventilation systems with heat recovery.

The Tochoji Temple originally dates from around the start of the 17th century, but the site features many 20th century buildings, to which the striking façade of the pavilion makes an exciting contemporary addition.

"Living as we do in the aftermath of the Great East Japan Earthquake, we have to think not only about seismic resistance but also the energy used in buildings," says the architects, who add that the pavilion was built with the goal of "creating a piece of religious architecture that will be passed down to future generations 100 years hence."

Photos: Satoshi Asakawa



ZERO COTTAGE, SAN FRANCISCO

Architect David Baker describes Zero Cottage as "an investigation of compact, sustainable urban development and a contemporary approach to living and working".

Baker certainly had a clear idea of what he wanted when designing the building, which contains both his own home and studio — the former on top, the latter on the bottom — in a compact 106 square metre space in San Francisco.

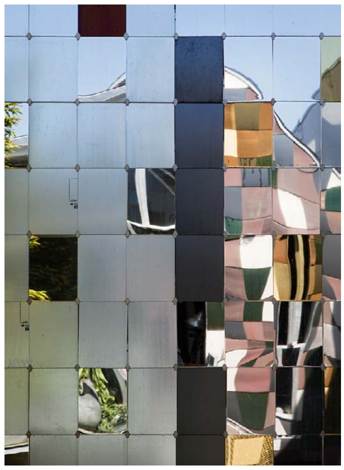
The timber frame structure features a unique rain-screen that Baker prototyped himself, comprised of salvaged and new metal slates that slide into custom metal clips, and which can be easily moved or replaced. There's even one clear plastic tile providing a view into the battening and rigid polystyrene insulation behind.

"The tiles rattle a bit in the wind. I choose to think of this as a charming effect similar to rain on a steel roof," says Baker. "Others might not be so amused."

Zero Cottage also features a vegetated roof that includes a drought-tolerant garden, a composting area, vegetable planters, and a solar hot water collector. Meanwhile a 3kW solar photovoltaic array covers the external staircase between the working and living spaces.

There are a host of other eco-features too, including salvaged wood floors, cabinetry made from the project's own wood waste, LED lighting, cellulose insulation, and an interior designed to be free of volatile organic compounds (VOCs).

Not only is the project certified by the Passive House Institute US (PHIUS, which is no longer related to the Passive House Institute or International Passive House Association), it also earned a LEED Platinum rating (the highest available) and is net-zero certified by the Living Building Challenge, with monitoring confirming that the PV array produces almost twice as much energy (5,533 kWh/yr) as the building consumes (2,897 kWh/yr).



Photos: Matthew Millman & David Baker Architects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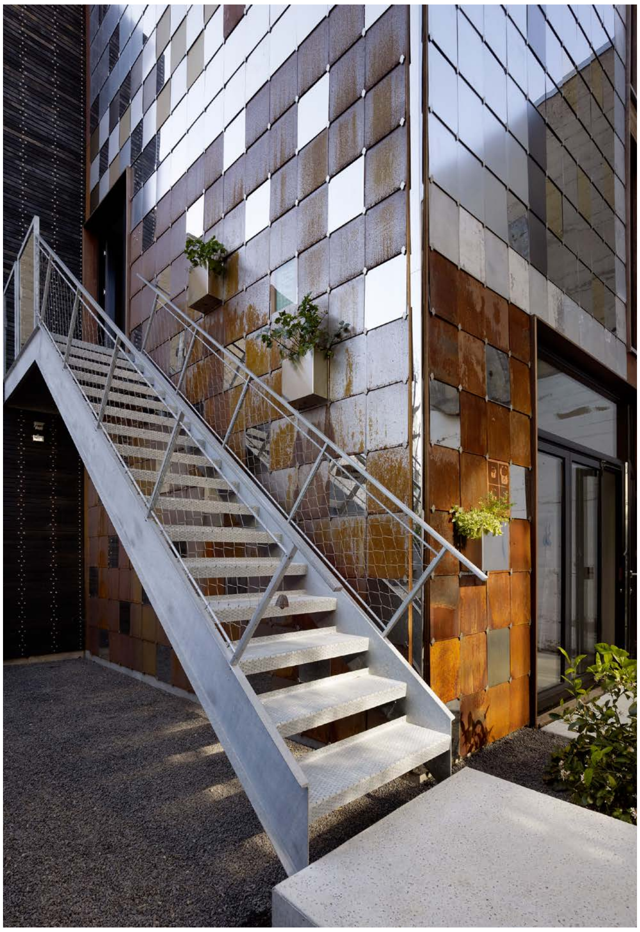
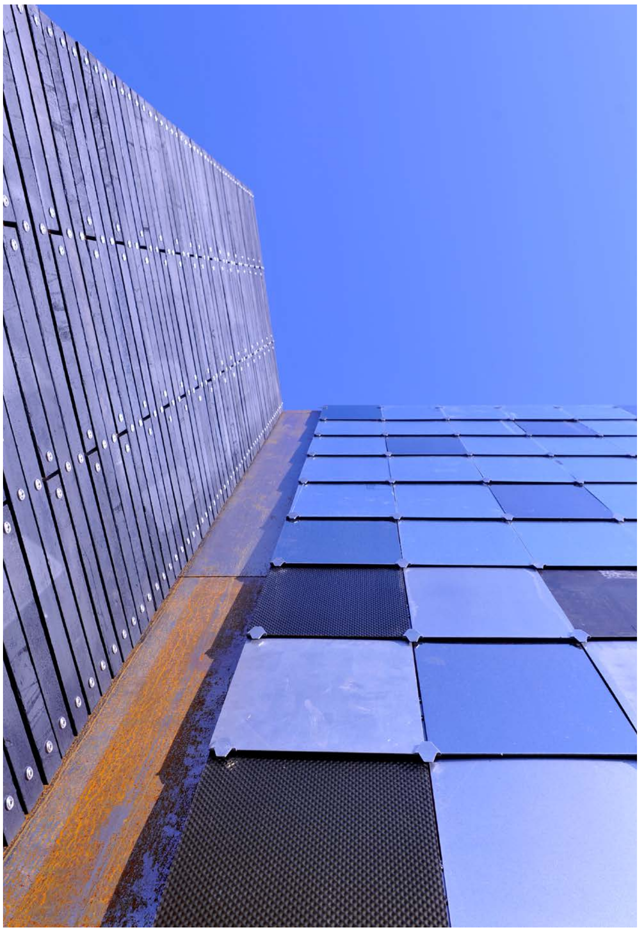




NEWS

Pavatex appears in V&A plywood exhibition

The free exhibition, Plywood: Material of the Modern World, will be running at the V&A museum in London till 12 November.

Pavatex, the innovative vapour-permeable wood fibre insulation from NBT, has been installed as part of an exhibition celebrating the use of plywood in construction, furniture and design at London's V&A museum.

Running until 12 November 2017 in the museum's Porter Gallery, the free exhibition 'Plywood: Material of the Modern World' brings together objects drawn from the V&A's world-class furniture, design and architecture collections with significant loans from across the globe. It aims to highlight how this often overlooked and much maligned material has helped to shape the modern world and become a 'hero material' in contemporary design and sustainable architecture.

Pavatex has been chosen for inclusion in the exhibition through Waugh Thistleton Architects, a Shoreditch-based architectural practice that has established a global reputation for engineered timber buildings. The firm pioneered the use of cross-laminated timber (CLT) in high rise structures with its Stadthaus scheme in Hackney's Murray Grove. This nine-storey development of 29 apartments has set the benchmark for sustainable residential projects of timber construction. Waugh Thistleton was asked to contribute to the plywood exhibition with a Stadthaus display, and provided a scale model of a typical wall-floor interface.

Architect Anthony Thistleton of Waugh Thistleton said: "As a natural, renewable, vapour-permeable wood product with excellent thermal properties and improved protection against fire, wood fibre insulation maximises the ease of construction, healthy living environment and carbon negative benefits that building with wood can bring."

The Stadthaus exhibit at the V&A's plywood exhibition features a 125mm thick timber wall with Pavatex wood fibre insulation on the exterior surface. The sample envelope structure has then been completed with external cladding and includes a thermal break and cavity fire break.

Andy Mitchell from NBT adds: "We are delighted that Pavatex features in the plywood exhibition at the V&A, as this exhibition aims not only to showcase the innovative use of engineered timber products in the past but also to highlight the pioneering uses they have now and in the future." ■

EVs can be used to power buildings, study finds

Stored energy from electric vehicles (EVs) can be used to power large buildings – creating new possibilities for the future of smart, renewable energy — ground-breaking battery research at the University of Warwick has shown.

Dr Kotub Uddin and colleagues demonstrated that vehicle-to-grid (V2G) technology can be intelligently used to take enough energy from idle EV batteries to be pumped into the grid and power buildings — without damaging the batteries. This new research into the potential of V2G shows that it could actually improve vehicle battery life by around 10% over a year.

The research was carried out by the university's WMG energy and electrical systems group, and in collaboration with Jaguar Land Rover. For two years, Dr Uddin's team analysed some of the world's most advanced lithium ion batteries used in commercially available EVs, and created one of the most accurate battery degradation models existing in the public domain to predict battery capacity and power fade over time, under various ageing acceleration factors — including temperature, state of charge, current and depth of discharge.

Using this model, Dr Uddin developed a 'smart grid' algorithm, which intelligently calculates how much energy a vehicle requires to carry out daily journeys, and – crucially – how much energy can be taken from its battery without negatively affecting it.

The researchers used their 'smart grid' algorithm to see if they could power WMG's international digital laboratory – a large, busy building which contains a 100-seater auditorium, two electrical laboratories, teaching labs, meeting rooms, and houses approximately 360 staff – with energy from EVs parked on the University of Warwick campus.

They worked out that the number of EVs parked on the campus (around 2.1% of cars, in line with the UK market share of EVs) could spare the energy to power this building – and that in doing so, 'capacity fade' in participant EV batteries would be reduced by up to 9.1%, and 'power fade' by up to 12.1% over a year. It has previously been thought that extracting energy from EVs with V2G technology causes their lithium ion batteries to degrade more rapidly.

The research paper, 'On the possibility of extending the lifetime of lithium-ion batteries through optimal V2G facilitated by an integrated vehicle and smart-grid system' is published in the journal Energy.

The technology to enable EVs to power buildings is starting to become commercially available, such as Nissan's V2G and X-Storage systems, which enable Nissan EVs to discharge battery power for use in buildings, to accept energy from micro-generators and to store energy – either from micro-generators or from EVs. ■

(above) A Nissan Leaf discharging energy into a building via Nissan's V2G system.

Norway to ban oil boilers from 2020

The Norwegian government has announced a ban on the use of oil and paraffin heating appliances for buildings from 2020. The ban will apply to residential, public and commercial buildings.

The rule will apply not just to new buildings but to all existing heating systems. Rural cabins not connected to the national electricity grid will be exempted from the ban.

It is estimated that there are up to 80,000 oil boilers in private homes in Norway, and 20,000 in larger commercial and residential buildings.

"Those using fossil oil for heating must find other options by 2020," environment minister Vidar Helgesen said.

Helgesen recommended alternatives such as heat pumps, wood stoves and direct heating using grid electricity, which in Norway is heavily based on hydroelectricity. ■

Leicester cathedral to get passive extension

Architecture practice vHH has announce that it is planning to adopt the passive house standard on a three-storey extension to the Grade 11 listed Leicester Cathedral, which is due to start on site in July 2019.

The project, dubbed Leicester Cathedral Revealed, is currently at the early design process (RIBA stage 2/3) with £3.3m Heritage Lottery Fund (HLF) secured and vHH putting a consultant's team together.

Aiming for passive house certification, the design proposes a reinforced concrete frame, generally with lightweight timber roof construction where the new structure abuts the cathedral. A key challenge of the 450 square metre scheme will be the passive house detailing in the basement, due to the proximity of cathedral walls in conjunction with the requirements of an archeological watching brief. ■

(right) An illustration showing the proposed 450sqm passive house extension to Leicester Cathedral.

Passivhaus Trust wins prestigious Ashden Award

The Passivhaus Trust picked up the 2017 Ashden Award for Sustainable Buildings at an award ceremony at the Royal Geographic Society in London on 17 June. Eight International and five UK Ashden Awards were presented, covering the themes of sustainable buildings, innovative finance, sustainable transport, women and girls, smart energy and more.

The Ashden Awards are a globally recognised measure of excellence in the field of sustainable energy. Former US vice president Al Gore was the keynote speaker at the ceremony.

"We are delighted that the UK's passive house community has been recognised for their work in promoting and delivering cutting edge, high comfort, energy efficient construction within the UK," said Passivhaus Trust CEO Jon Bootland. "There are over 65,000 projects certified to the passive house standard globally and awareness is growing rapidly here in the UK. We hope that by winning the prestigious Ashden Award, it will help the passive house standard extend its reach into the mainstream construction industry. We hope the success has a far-reaching positive effect."

The Ashden Award Judges commented that the Passivhaus Trust's approach is one of "rigour and quality assurance, and by acting as a bridge to a globally recognised international standard, the trust is both changing mindsets and enabling the building community when it comes to sustainable building practices." ■

(left) Pictured at the Ashden Awards are (l-r) Garfield Weston Foundation trustee Melissa Murdoch who presented the award; Passivhaus Trust chair Chris Herring; associate Yogini Patel; and CEO Jon Bootland.

OUR PASSIVE JOURNEY

Is our proposed house too big?

An oversized passive house may be no more sustainable than a correctly sized house built to a more modest spec. In the latest instalment of her journey to build a passive family home, Nessa Duggan finds that visiting some real passive houses may force a change in approach regarding size and complexity, with potentially significant cost benefits.

During Easter break in the sunny south east, we were fortunate to visit two recently completed insulating concrete formwork (ICF) passive houses. The new homeowners were kind enough to share their experiences from start to finish and talk about the thought processes throughout their projects. One was a family with three young children, and the other was at the stage of grandchildren visiting. Both very relevant to our situation in planning a forever home.

Physically walking around these houses, chatting with people at the end of the process we were starting, was invaluable to us. Sharing experiences of everything from window sills to attic hatches, balancing priorities throughout the planning, tendering and building processes brought fantastic insight.

At circa 240 sqm, both houses felt very spacious – more than adequate for our needs. This confirmed something we suspected, the 292 sqm house in our planning permission was too big. Having grown up in a rambling 370 sqm house, large was not on my list of priorities.

During the tender process for our self-build project, issues arose regarding construction of the design, including challenging airtightness details with sliding glazed doors, the support of a roof overhang, rainwater drainage from the roof through the centre of the house and the necessary addition of an ancillary heat source due to the large volume / floor area. All these issues added unnecessarily to the challenge of achieving the passive house standard.

The resounding advice was clear: if you want to achieve passive standard, keep it simple. The growing list of complications and compromises brought us to the conclusion that our project was anything but simple.

Having drafted a detailed brief at the outset, somehow along the way we lost sight of our vision, and hadn't revisited this brief since drafting it. We got excited by the plans initially presented by an architect we hired and unfortunately ignored the fact that they did not align with our vision. This proved to be a very costly oversight in both time and money.

A year down the line and better equipped with practical advice, we decided to realign the project to the original brief. We set about modifying the plans with the original headline of 250 sqm max and an aim to eliminate the construction and energy balance challenges.

Without furniture to scale included, we had difficulty getting an appreciation for floor areas from planning drawings. We consulted an interior designer to discuss internal layout of living areas to address this concern. Armed with our original brief and existing house plans, we came away with a revised kitchen / diner layout with amendments to the position of doors and windows lined up with the internal flow of living space. Placement of windows carefully considered natural lighting and facilitated effective natural ventilation.

Revised construction drawings integrated the interior designer's advice, simultaneously addressing construction and energy balance complications. A detailed kitchen / diner plan gave us confidence to rationalise the use of space and reduce the floor area by 48 sqm in the single-storey section of the house. The reduced footprint combined with removal of vaulted ceilings greatly reduced the volume to floor area ratio that necessitated an ancillary heat source.

A simplified roof design eliminated the need for complicated rainwater drainage. The ratio of window to floor area reduced from 25% to 15% overall by removing a large proportion of the glazing in the kitchen. Removal of floor to ceiling glass with sliding doors addressed airtightness challenges and improved privacy to the kitchen from an overlooking property to the rear.

> “Physically walking around these houses, chatting with people at the end of the process we were starting, was invaluable.

All these changes brought the added bonuses of increasing the garden area and significantly reducing the cost of glazing. Construction would be more straightforward and the main living area much cosier.

On presenting drawings of the proposed changes to the local planners, the advice was to submit a new planning application, so that's the next step. To move forward with conviction, again we need to take two steps back.

We have slowly worked through the challenges that arose at various steps along this process, enjoying the detail in most parts. In the absence of time pressure to complete the build, we are highly relieved to come to this conclusion before beginning construction, too late to rectify without careful consideration. ■

WHAT IS THE:

AECB Silver Standard?

In the current policy vacuum, many questions have been raised about the future of sustainable construction. Despite this uncertainty, there is a steady growth of interest in the AECB Silver Standard, writes architect Mark Siddall.

A 1960s detached bungalow in Canterbury recently retrofitted to the AECB Silver Standard by Conker Conservation.

In the right hands, compared to the way the industry currently works, the AECB Silver Standard can be used to dramatically improve design and construction practice. The standard was designed for new buildings but has recently been used successfully to improve existing ones. It can also deliver significant benefits in occupant health and well-being, thermal comfort, good air quality and of course, lower energy bills.

AECB Silver can be used as a certifiable, coherent and cost-effective first step on a journey towards adopting the passive house standard. It is considered a sensible building standard in its own right, by reference to government standards abroad, such as Canada's R-2000 or Switzerland's Minergie. Or it can be a backstop standard for projects aiming at passive house, but just falling short because of an unexpected design or construction situation.

On average in the last four years, 30,000 people per winter have died in England and Wales from conditions brought on by the cold. It is estimated that approximately 2,000 to 7,000 people per year will die of heat-related causes by 2050, triple current levels. The AECB Silver Standard is firmly positioned to help address both of these problems.

With adequate knowledge and understanding, it's straightforward for AECB Silver to deliver passive house type levels of thermal comfort. The main difference is slightly higher energy bills and slightly higher carbon emissions from the building's heating system, assuming that the heating system is unchanged.

One key benefit offered by the standard is a wider choice of, for example, windows and doors or ventilation systems. Unlike some standards, you are not bound into using particular technologies; instead it is for the project team to determine the best way ahead. This gives considerable opportunity to consider design strategies that resolve both the budget and performance requirements. At the same time, by having a firm focus upon the fabric, the standard encourages homes and buildings with low maintenance and a long life.

While you don't need to be a certified passive house designer to design to the standard, it helps. Crucially, someone in your project team will need to be competent in the use of the Passive House Planning Package (PHPP). You'll also need someone with a good understanding of how to design out thermal bridging and achieve good standards of draught proofing.

To make AECB Silver easier to achieve, the client and design team should make use of AECB CarbonLite guidance to guide crucial early decisions. However there are two powerful rules of thumb. A simple building shape with a low 'form factor' significantly reduces costs and helps achieve excellent airtightness with ease. An early review of the designer's / contractor's preferred method of construction is essential, to make designing out thermal bridges easy. It also helps ensure draught proofing measures are simple, affordable and effective to deliver.

If you are the client, you should ideally look for a project team with experience of delivering very low energy buildings. Or failing that, at least seek those who can provide evidence of relevant low energy CPD or passive house and AECB CarbonLite training. One of the best ways to verify their ability is to request records of built projects' airtightness targets and actual results. If your project team needs briefing on the basics, they can download the AECB Silver Standard Guidance for free from the AECB website. Once they have joined the AECB, they can download very useful example low energy construction details for masonry and timber frame building based around different construction methods.

If you're an inexperienced designer and you want to hone your skills, then you may wish to consider attending a CarbonLite Training Course. Another option might be to hire an expert for a brief design review before key decisions become irreversible.

The cost of third party certification can be onerous, especially on individual buildings. One great advantage of the AECB Silver evidence-based certification process is that the certifier can be a nominated member of the project team. Upon completion and uploading of the design and construction evidence, the AECB issues a certificate for the project.

Whether it is a home, office or hotel, or other structure, if you intend to create a high-performance building by UK standards the AECB Silver Standard may be what you are looking for.

For residential design, the moderately stringent space heating demand suits low-rise UK housing, ie. not just the dwelling types more common in some other European countries. For instance, up to 50% of all dwellings in Germany and Sweden may be flats.

Parameter	Target	Notes
Delivered heat and cooling	≤ 40kWh/(m^2.a)	According to PHPP
Primary Energy demand	Varies Wh/(m^2.a)	According to PHPP. Varies by country. UK: 135 kWH/m^2/yr
Airtightness (n50)	≤ 1.5 h-1 (≤ 3 h-1)	With MVHR (with MEV)
Thermal bridges	Psi external <0.01 W/m	Calculated if > 0.01 W/m. Standard passive house methodology
Summer overheating	<10%	<5% recommended

Developed and refined over nearly a decade, AECB Silver has become increasingly aligned with the quality assurance that supports the passive house standard. By having the Passive House Planning Package (PHPP) at its core, AECB Silver is indirectly backed up by all the scientific rigour of the Passive House Institute.

This year the AECB is reviewing the standard's criteria, in the light of feedback to date and developments in building practice. The team are also considering improvements to the self-certification system in the light of recent CarbonLite Retrofit Programme work to extend the system to include moisture-robust retrofit certification.

If you would like to build a project to the AECB Silver Standard, you can find out more at **http://tinyurl.com/aecbsilver**. ■

Build your network at the AECB National Conference this September in London

Anticipation is high following the success of the very first Eco Connect in Wales.

The very first Eco Connect event took place in Swansea on 29 June, emphasising the strength of the AECB network and the importance of such events for the AECB and wider building community. The one-day gathering in Swansea focused on raising the quality and quantity of sustainable house building and retrofit in Wales.

Delegates from across the housing and domestic construction sector and beyond were engaged by keynote talks, networking opportunities and a site visit to the SPECIFIC Active Classroom (Buildings as Power Stations). It was also a great opportunity for members to catch up with the AECB team including the CEO Andy Simmonds, who said he found the day both useful and informative. "Throughout the day, I made several useful connections for the AECB, as well as being able to speak to several product suppliers concerning various aspects of my own practice's passive house projects," he said.

The AECB National Conference already has over 100 registered delegates. It is taking place on 15 September at the Savoy Place on London's Embankment, home to the Institute for Engineering and Technology. It is co-located with the International Refurbishment Symposium, and AECB delegates will be able to attend both conferences. The event features 30 expert speakers, a curated exhibition of eco products, technologies and services and, of course, the opportunity to meet and engage with like-minded professionals. Expect to see many more public-sector delegates this year too.

This year the event will concentrate on the future of house building and retrofit. The housing white paper published in February 2017, titled 'Fixing our Broken Housing Market', called for radical solutions to an ever-worsening problem. With soaring prices in some regions, rising homelessness, and deteriorating living conditions in private-rented properties, it's a statement that is hard to argue against. That's without even mentioning carbon emissions and rising fuel prices. Failing and defective buildings have seldom escaped the news of late, bringing the topic into greater focus. There can be no escaping that fewer homes are being built, living standards are declining and houses are less and less affordable.

The conference will therefore address the fundamental questions of government intervention, alternative development models and the raising of quality and quantity. Britain has had Western Europe's lowest rate of house-building for three decades: will the government's target to deliver between 225,000 and 275,000 per year be achieved? Will it be enough? And to what standards? And what about the sustainability agenda?

Speakers will identify the risks and opportunities presented by government policy, including the impact of Brexit and a fragile minority government. They will look at the lessons from volume housebuilding and some of the alternative models for housing delivery. They will highlight how sustainable design and construction approaches, including factory build, can deliver improved living environments without slowing the development process.

These central issues will be discussed by experts from across the field, with contributions from AECB CEO Andy Simmonds, housing policy expert at the charity Shelter, Toby Lloyd, and other experienced professionals from across the industry. All participants are encouraged to engage in the sessions and help shape the housing issues addressed. Whether you are a developer, architect, builder, student or interested individual, this one-day event is undoubtedly worth your time.

And it that's not enough to tempt you, the day will be topped off with the Eco Connect Summer Party, on the venue's spectacular roof terrace, overlooking London's South Bank and the London Eye. Wind down with some drinks, a BBQ and live entertainment and like-minded people.

Register now at **www.ecoconnect.co.uk**. Tickets cost £199 plus VAT, giving access to both conferences, the exhibition and also including lunch. AECB members receive a 10% discount. To obtain a discount code, contact Emma Furniss, at **emma@aecb.net**.

This year Eco Connect London / The AECB National Conference is also providing a platform for exhibitors to connect and do business with potential new partners and colleagues. Exhibitor packages for the national conference include access to the delegates from both the AECB's National Conference and the International Refurbishment Symposium through a shared exhibition and catering space.

For more information on exhibition space at the conference, get in touch with James Allen at Osmosis at **james@osmosisconsult.com.** ■

TIMBER & STRAW PASSIVE HOUSE PLUS IS A

WORLD FIRST

Built with a timber frame insulated with straw-bale, and featuring an extensive suite of ecological and recycled materials, this stunning North Yorkshire home also produces more energy than it consumes, making it the first straw-bale building in the world to reach the brand new 'passive house plus' standard.

by David W Smith

Zero

annual heating costs - or estimated £170 per year when leftover wood from build runs out.

Building type: Three-storey 145 sqm timber frame & straw-bale house

Completed: January 2017

Location: Leyburn, North Yorkshire

Build method: Cavity wall

EPC: A

Standard: Certified passive house plus

Electricity bills: £32 per winter quarter (January-March 2017)

WANT TO KNOW MORE?

The digital version of this magazine includes access to exclusive galleries of architectural drawings.

The digital magazine is available to subscribers on www.passive.ie

Behind the construction of the straw-bale Leyburn passive house in North Yorkshire lies a long saga with many twists and turns. For the two owners, Ruth Barnett and Peter Richardson, it took personal sacrifice and determination to overcome fierce local opposition in order to build their dream home. But, after two planning refusals and a defeated appeal, the story ended in triumph when the redesigned house achieved certification to the new 'passive house plus' standard, which recognises the on-site production of renewable energy as well as the energy efficiency of the building.

The Leyburn passive house is unlike any other home in the Yorkshire Dales. The design is modern, but the cladding in local stone means that it blends in well with its surroundings, and there are lovely views over the hills from the slightly elevated position on the outskirts of the small market town. "There was a lot of antagonism and petitions from local people and it took three years to get it through planning," says architect Adam Clark, of Halliday Clark Architects. "But we kept dusting ourselves down and took the suggestions of the planning team on board and tried again. Eventually it got through."

Clark said that opposition to this type of modern design was common. "We get it a lot all over the country because our schemes tend not to be traditional in design," he said. "There are photovoltaic panels (PVs) on the roof and zinc cladding, creating a different palette of materials from other houses in the area, yet we have introduced stone cladding that has been sourced locally."

Nevertheless, Ruth Barnett stresses that there was some support for the project locally too, and that many who initially objected have now changed their minds. "People come round at weekends to see the house and nearly all have a very positive reaction," she says. "The stone cladding means it fits in better than a lot of the red brick houses in the area. There were also misunderstandings. Some locals were objecting to pictures they'd seen of the architect's white model, but we never wanted to build a white piece of cardboard."

Barnett has always been interested in green architecture and modern design. A chartered surveyor by profession, she has a master's degree in building conservation. Her dream of constructing an ecological house began 15 years ago when she read Barbara Jones's book 'Building with Straw Bales', which fired her imagination. Then, a few years later, she read Will Anderson's 'Diary of an Eco-Builder', which inspired her even more. Her partner, Peter Richardson, is a graphic designer and shares her passion for green design. They set about trying to find a plot that would accommodate a straw-bale house.

The pair found the site they wanted in Leyburn several years ago, but that was just their beginning of the struggle. The

Photography: Paul White

THE STRAW-BALES WERE SOURCED FROM A LOCAL FARMER.

Explained:

The ***'passive house plus' standard*** is a new certification category designed to recognise the production of on-site renewable energy by passive buildings. It requires a minimum of 60k $kWh/m^2/yr$ of renewable energy generation, along with a maximum renewable primary (PER) energy demand of 45 $kWh/m^2/yr$. PER is a new energy factor developed by the Passive House Institute designed for a future where electricity grids are powered entirely by renewables. It is designed to replace traditional primary energy demand in the long term. In this case, a higher PER demand, 56 $kWh/m^2/yr$, was allowed because the dwelling produces much more (83 $kWh/m^2/yr$) than the renewable energy generation target.

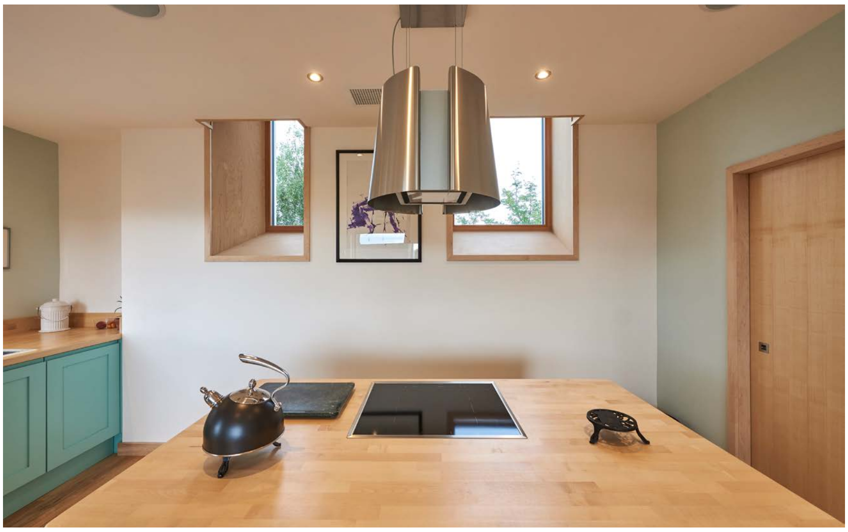
The even more advanced 'passive house premium' standard requires generation of 120 $kWh/m^2/yr$ and a maximum PER of 30 $kWh/m^2/yr$. Meanwhile under this new system, the traditional passive house standard is rebranded as 'passive house classic', and has a max PER of 60 $kWh/m^2/yr$, with no renewable generation required.

This new classification system is operational alongside the traditional passive house standard, with its maximum primary energy demand of 120 $kWh/m^2/yr$, and no requirement for renewable energy production. The targets for space heating demand (15 $kWh/m^2/yr$) and heat load (10 W/m^2) remain the same under both certification systems.

plot was in the Quarry Hills Conservation Area, which comprises a former Victorian workhouse and infirmary. The latter was converted into a pair of semi-detached houses nearly 30 years earlier. Barnett and Richardson bought one of these dwellings, which they now rent out, along with their site because the owners would not sell the plot alone. And although the site had been earmarked for development, and there had been two previous planning applications, nothing had been built yet.

Having sold their old home near Masham, they moved to Leyburn and commissioned Adam Clark to design a straw-bale house to level six of the Code for Sustainable Homes, the highest achievable rating.

Unfortunately, resistance to the design was intense. Richmondshire District Council, the Civic Society and the Town Council all opposed the development. "They were concerned that the initial design projected too far forward from the existing building, and wasn't simple enough in terms of its ▶



THE FIRST QUARTERLY ELECTRICITY BILL OF 2017 CAME TO JUST £32.

composition to fit in with the surrounding houses in the conservation area," says Clark.

At this early stage, there was no intention to build a passive house. But that all changed in March 2015 when Barnett approached Thomas Froehlich, a German structural engineer based in Scotland, for help in achieving code six status. Froehlich is the managing director of Ecowin, who sell Austrian-made Gaulhofer windows, but he is also a passive house consultant and suggested building to the standard. Ruth and Peter were excited by the idea and agreed it was the best way forward, and decided to aim for the passive house standard instead of code level six.

"But there were some difficult conditions to overcome to make it a passive house," says Froehlich. "Firstly, it's in a conservation area, which imposes restrictions. Secondly, it was not designed as a passive house and any alterations had to be made within planning limits using PHPP [the passive house design software], which was quite an exercise and we got through it by the skin of our teeth."

And while passive buildings should ideally be as compact as possible to minimise the surface area for heat loss, this one was not, with a form factor (the ratio of the total surface area of the thermal envelope to the treated floor area) of 3.4, whereas 3.0 or under is ideal for meeting the passive house standard. The house's thermal envelope is smaller than it appears. Outside of the treated floor area of 145 sqm – a relatively modest size for an architectural self-build – a garage and rooftop terrace eat into the footprint of the ground floor and second floor respectively.

Froehlich worked with Adam Clark to make sure the design could meet the passive house standard. Barnett and Richardson were committed to using natural materials wherever possible. The project used recycled concrete aggregate in its foundations and no cement-based products above ground. The interior was lined in lime plaster with a breathable Lakeland paint finish. "It's very unusual to create a hybrid like this with all natural materials," says Froehlich. "We weren't even allowed foam around the windows."

Froehlich made regular site visits and carried out the 'toolbox talk' on the passive house standard for the trades on site. He says, "When we first carried out a pressure test, the airtightness reading was 1.6, but because of the size and shape of the house we had to get it down to 0.3. It's difficult with a hybrid structure, as you have to figure out how the render and the plaster will fit on the straw-bale. It took a few weeks but we managed it in the end due to the lime render and the airtightness."

Though Adam Clark is enthusiastic about building with straw-bale, he is less fond of using the material for the load bearing structure. "You can use it that way, but it restricts your construction sequence, so we used the bales as insulation rather than as a structural element. I developed a technique of using TJI beams made from softwood and OSB. We created deep wall structures with structural bays that the bales could slot into."

SELECTED PROJECT DETAILS

Clients: Ruth Barnett & Peter Richardson
Architect: Halliday Clark
Structural design: Buro Happold
Electrical contractor: Gregg Electrical
Airtightness testing & SAP assessment: Award Energy Consultants
Misc. green building materials, sheep's wool, foamed glass fill: Womersley's Ltd
Misc. green building materials: MKM Building Supplies
Airtightness products & MVHR: Green Building Store
Windows, doors & venetian blinds: Ecowin
Roof window: Fakro, via MKM Building Supplies
Wood burning stove: The Stove Gallery
Solar PV: Gregg Electrical
Rainwater harvesting system: Rainwater Harvesting Ltd
Water conserving fittings & towel rails: Ripon Interiors
Reclaimed maple: Heritage Stone
Natural paint: Lakeland Paint
Cork underlay: Siesta
Kitchen units with recycled content: Milestone Design

"The straw-bales were sourced from a local farmer. With regard to longevity, they are installed within a double membrane structure," he says. "The external membrane prevents water ingress from the external environment, and the intelligent membrane to the inside face of the bales enables moisture to pass out of the bale if needed, but prevents moisture within the building passing into the bale."

Renewable energy was obviously essential for achieving the passive house plus standard, which was introduced in 2015 along with the 'passive house premium' standard to recognise the production of renewable energy on-site (see explainer). The roof of the house features a 5.8kW array of Trienergia solar photovoltaic panels — each of the 29 panels has an output of 200W. The planning inspector stipulated that the PV array must cover the entire roof in order to achieve a uniform appearance, and Barnett spent a fair amount of time trying to find a PV product that could meet this demand and fit together to neatly cover the entire roof.

But Barnett took a hands-on approach during the build, and was happy to work on sourcing products herself, and in supervising on-site. "It was very much a self-build as the client hunted down materials and ran the scheme on site," says Adam Clark. "Ruth and Peter are passionate and adamant about what they want. They are also knowledgeable and monitored everything well, so the need for a day to day involvement on site was not required."

Barnett managed to source some of the products she needed from an eco-building supplier, Womersley's Associates in West Yorkshire. But tracking down other components, such as the foamed glass products used to prevent thermal bridging below the ground floor was more challenging.

"The build began in May 2015 and the daily involvement was intense," Barnett says. "There were a lot of people to satisfy. We had to source materials that were compatible with passive house rules, but also planning and building regulations, as well as the engineer's stipulations."

The couple moved into the house in January of this year, and since then Barnett has emailed Passive House Plus a couple of times with updates on how the house is performing.

"We are finding the external venetian blinds extremely effective in controlling overheating and have used them on numerous occasions," she says. "We prefer them to fixed shading due to the flexibility they offer — we can decide when to block out the sun rather than having it decided for us."

She also told us that the first quarterly electricity bill of 2017 came to just £32, with the Immersun controller for the solar PV system efficiently diverting excess generation to the hot water tank, meaning that as of mid-June, they had not needed to use the electricity grid to heat water at all. There is only one standalone stove, which burns wood leftover from the build and from trees taken down during site works, and three 70W electric towel rails.

As a result of working on the project, local tradespeople have now developed a specialism in passive house construction, which they can now take onto other builds. Meanwhile Thomas Froehlich and Adam Clark have since worked on two other passive house projects together – one in Ripon, North Yorkshire, and the other in Hawksworth, near Leeds.

Though the impetus to create a passive house came from Thomas Froehlich, he initially had doubts about building with straw-bale. But the success of the Leyburn house has transformed his view.

"This house converted me and if I built a passive house myself from scratch I would now do it with straw-bale. Most houses built in straw-bale are standard boxes, but this one isn't and it proves what can be done with it. We were happy to achieve passive house status, and at the end of the day to get the passive house plus standard was the icing on the cake." ▶

CONSTRUCTION IN PROGRESS

1 The roof build-up features 300mm Thermafleece Ultrawool insulation; **2** The timber frame structure filled with 405mm straw followed by a pro clima Intello membrane; **3** Delivery of the straw-bales, which were sourced from a local farmer — the house is the first straw-bale building in the world to reach the brand new 'passive house plus' standard; **4** Unused electricity from the solar PV array is diverted to the 125L hot water cylinder, which is wrapped in Ultrawool insulation; **5** Ultrawool insulation lagging on hot and cold water pipes; **6** Wood fibre insulation to the inside of the wall build-up.

IN DETAIL

Building type: 145 sqm treated floor area, detached three-storey timber frame house with straw-bale infill.

Location: Leyburn, North Yorkshire

Completion date: January 2017

Budget: Confidential

Passive house certification: Passive house plus certified

Energy bill: £170 per year for space heating, not including hot water (calculated using space heating demand from PHPP and average cost of wood logs as published by www.confusedaboutenergy.co.uk. In practice the house is heated with free waste wood leftover from construction/site works). Quarterly electricity bill of £32 for March to May, including VAT & standing charges, not incl feed-in-tarriff.

Space heating demand (PHPP): 15 kWh/m²/yr

Heat load (PHPP): 13 W/m²

Primary energy demand (PHPP): 56 kWh/m²/yr [aka primary energy renewable or 'PER' demand]

Heat loss form factor (PHPP): 3.41

Overheating (PHPP): 2% (of time indoor temp above 25C

Environmental assessment method: None

Airtightness (at 50 Pascals): 0.30 ACH

Energy performance certificate (EPC): A 103

Thermal bridging: TeploTie low thermal conductivity cavity wall ties, Foamglas blocks, fibreboard waist at floor/wall junctions, thermally broken window frames, insulated reveals. Calculated Y-value: 0.019 W/m²K.

Ground floor: 1.4m strip concrete foundations with recycled aggregate. 500mm Foamit crushed glass, followed above by 50mm Foamglas slab; 250mm Limecrete with glass fibres; 100mm Thermafleece Ultrawool, finished above with reclaimed maple flooring. U-value: 0.082 W/m²K.

Walls: Lime render externally on 40mm fibreboard, followed inside by ventilated cavity, pro clima DB+ breathable membrane, timber frame filled with 405mm straw; pro clima Intello membrane; 60mm fibreboard; 20mm lime plaster internally. U-value: 0.087 W/m²K.

Roof: Solar PV array on liner tray system to south facade and natural slate to the north, followed inside by ventilated cavity, Nilvent breathable roofing felt, followed inside by 18mm OSB, 300mm Thermafleece Ultrawool insulation, 18mm ply, pro clima Intello membrane, 60mm fibreboard, 20mm lime plaster. U-Value: 0.092 W/m²K.

Windows: Gaulhofer Fusionline 108 triple glazed aluminium-clad larch windows, with argon filling and an overall U-value of 0.72 W/m²K.

Roof window: 5 x Fakro FTT-U6 triple glazed roof window with EHV-AT thermal flashing and overall U-value of 0.8 W/m²K.

Heating system: Burley Springdale 3KW wood burner with 88.9% efficiency, 3 JSS Cinder x 70W electric towel rails. Immersun diverting otherwise unused electricity from solar PV array to the 125L hot water cylinder, before sending the remaining excess electricity to the grid.

Ventilation: Paul Novus 300 MVHR. PHI certified heat recovery efficiency rate of 94.4%.

Electricity: 29 x 200W Trienergia solar PV panels totalling 5.8kW, generating 83 kWh/m².

Green materials: Reclaimed limestone, straw-bales, concrete with recycled aggregate, lime render and plaster, limecrete, wood fibreboard insulation, recycled foamed glass, all timber FSC or PEFC certified, reclaimed floorboards, recycled rubber flooring, cork underlay, sheep's wool, cellulose and earthwool insulation, low flow taps, low flush WCs, rainwater harvesting, natural paints and oils, recycled plastic drainage products, recycled paper airtightness membrane, recycled plasterboard, recycled aluminium blinds, kitchen units including carcase from recycled particleboard, LED lighting.

(above) Handing over the certificate for reaching the new passive house plus standard, pictured are (l-r) Ruth Barnett, Ecowin MD Thomas Froehlich, Peter Richardson, and Adam Clark of Halliday Clark Architects.

£317
annual estimated heating costs

Building type: Three-storey, 420 sqm timber frame house
Completed: June 2015
Location: Mayfield, East Sussex
Build method: Timber frame
EPC: B
Standard: Certified passive house
Budget: £900,000

LARCH-CLAD PASSIVE HOUSE

INSPIRED BY A VENN DIAGRAM

With an intricate design based on the concept of two pitched-roof sections that overlap, this eye-catching timber-framed Sussex home proves you can meet the passive house standard with just about any shape.

by David W Smith

Photography: James Galpin

WANT TO KNOW MORE?

The digital version of this magazine includes access to exclusive galleries of architectural drawings.

The digital magazine is available to subscribers on www.passive.ie

In designing a passive house for a private client in Mayfield, East Sussex, architect James Galpin of Hazle McCormack Young LLP was asked to create a home that felt "at one with the gardens in the surrounding landscape, but which also performed well thermally".

The brief was particularly challenging as Galpin was given a strict budget for a large house that had to accommodate a family with five children.

The central design involved overlapping a pair of traditional pitched roof house forms to create a three-dimensional 'Venn diagram'. This overlap created the heart of the house — the entrance atrium and staircase.

Each of the rooms surrounding the central atrium has direct views along the principal axis lines of the surrounding landscape, as well as from room to room, creating an interior which "feels like a sheltered part of the garden," Galpin says.

He continues: "The key characteristic of this site is the mid-century Percy Cane [a renowned English garden designer] landscape design and its rural setting. Our intention was to create strong visual links between the interiors and the landscape from each of the principal rooms."

Although the Venn diagram design facilitated connection with the landscape, it reduced the efficiency of the surface area to volume ratio, creating more surface area through which heat could escape, making it trickier to reach the passive house standard.

Galpin's team managed to overcome this problem by insulating both the walls and roof to onerous U-values of around 0.09, and a similarly impressive 0.105 in the ground floor thanks to the Isoquick insulated raft foundation system. The measured primary energy demand is almost exactly as modelled in PHPP, the passive house design software, at 95kWh/m^2/yr. The owners report that it is warm and comfortable inside, even when they return from a period away.

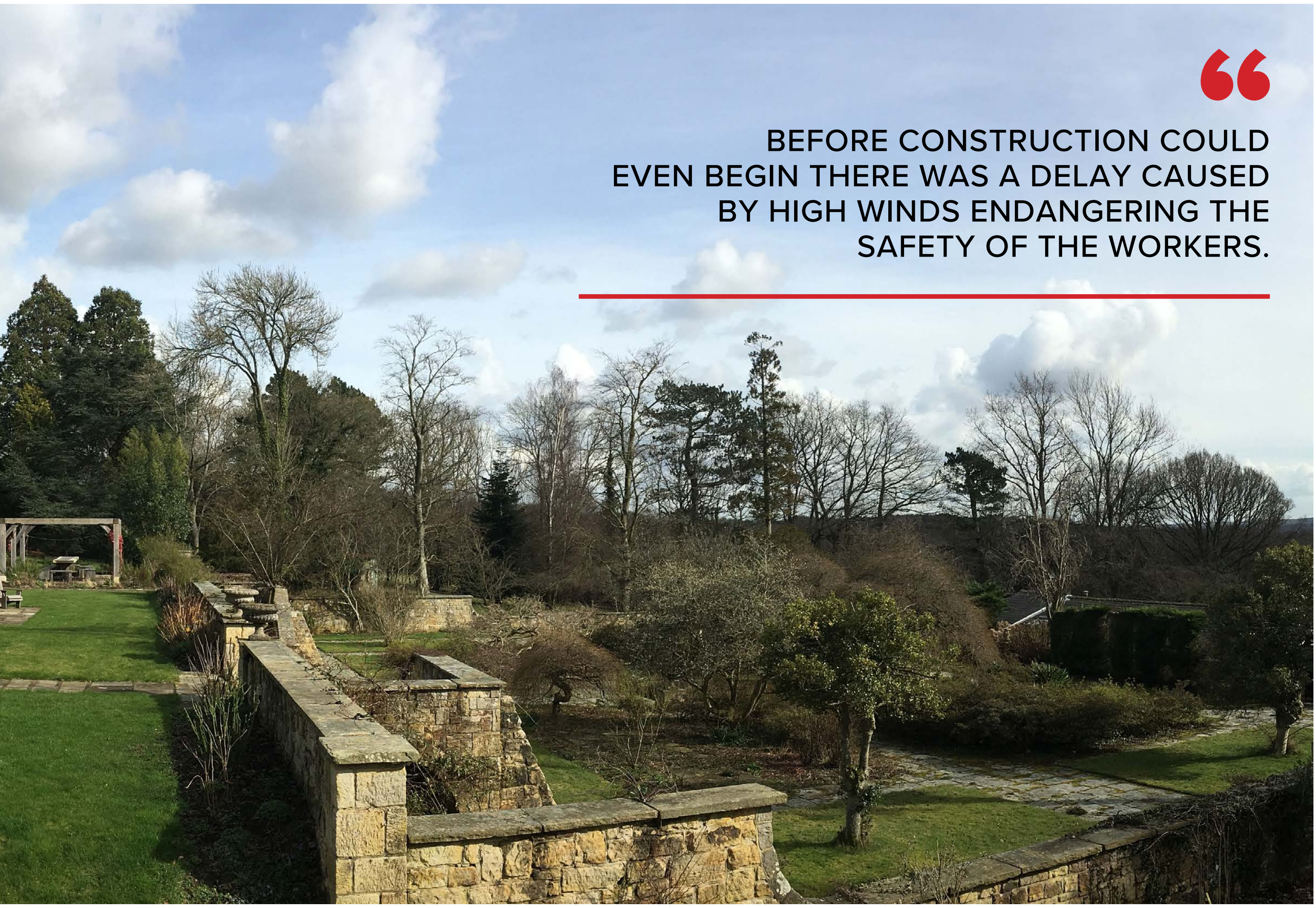
The client also says heating bills are around £2,000 less per annum than the 260 sqm bungalow that used to be on the site, though the house is not occupied full-time, making exact comparisons tricky. The large MVHR system allows the dwelling to cope with variations in the number of inhabitants (the house can have as many as 22 occupants when guests are over).

Throughout the project, the technical challenges were compounded by the requirement to stick within a strict budget of £900,000. While this might seem like a hefty figure, it had to include a two-storey guest house / garage building as well as the main passive-certified dwelling.

Budget issues were discussed at every meeting and the contractor, architect and client all searched across suppliers for the best deals on fittings, furnishings, sanitaryware and other components. "The challenge was met well, with a high-performing building built from top quality materials for less than £1,800 per square metre," says Galpin.

Contractor Richardson & Peat prefabricated the timber frame system off site, and it

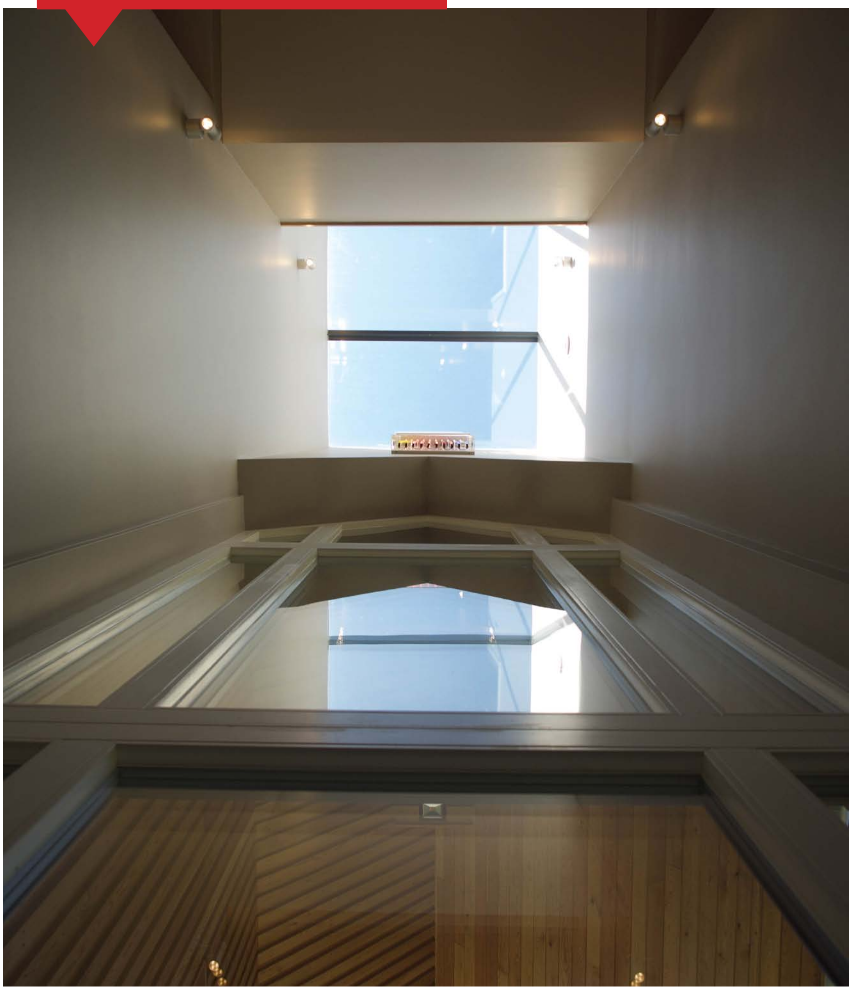
> THE TEMPERATURE IS STABLE, CONTINUOUS AND COMFORTABLE, WITHOUT DRAUGHTS AND COLD SPOTS.



BEFORE CONSTRUCTION COULD EVEN BEGIN THERE WAS A DELAY CAUSED BY HIGH WINDS ENDANGERING THE SAFETY OF THE WORKERS.

Explained:

Heat loss form factor is a measure of how compact a building is. It is the ratio of the surface area of the thermal envelope to the treated floor area. The higher the figure, the less compact the building, meaning there is more surface area from which heat can escape, making it more difficult to meet the passive house standard.



features 400mm studs insulated with Knauf Frametherm mineral wool. At an early stage, a decision was taken to use Siberian Larch cladding which, once it has weathered a bit, should fit in nicely with the surrounding limestone terraces.

But before construction could even begin there was a delay caused by high winds endangering the safety of the workers. The site is quite exposed at the top of a valley, where south-westerly prevailing winds sweep through, and the OSB boarding to the face of the timber frame panels acted like sails in strong winds.

"It forced the erection process to halt several times due to health and safety issues, but we managed to recover the programme time after the initial delay," Galpin says.

While the original kitchen design featured a bi-folding door that met at one corner of the house, opening that whole corner to the garden, in reality there was no product on the market at the time which delivered the required level of airtightness.

"Despite these minor glitches, the house was erected without any major problems due to the accuracy of the IsoQuick raft insulation and the timber frame panels," Galpin says.

He concludes: "The client enjoys modern architecture and is happy with the way the house sits comfortably in its rural setting, but feels contemporary in its design. It's also the first house interior they have experienced where the temperature is stable, continuous and comfortable, without draughts and cold spots."

SELECTED PROJECT DETAILS

Architect: Hazle McCormack Young LLP
Passive house consultant: Aaben Ltd
Structural engineering: Crouch Waterfall Ltd
Main contractor & timber frame: Richardson & Peat
Passive house certification: Warm
Mechanical contractor: Thomson Ellis Ltd
Electrical contractor: Ambassador Electrical Services Ltd
Airtightness testing: Anglia Air Testing
Mineral wool insulation: Knauf
Insulation foundation system: Isoquick
Window & doors: Norrsken
Roof window: Glazing Vision
Pressed metal radiators: Myson
MVHR: Systemair
Lighting: Collinwood Lighting

Architect's comment

The original house on the site was a 1950s bungalow with space in the roof. It was very poor in terms of thermal performance, being very cold in the winter and using a large amount of oil to heat. The initial brief for the replacement dwelling was to create a house which felt at one with the surrounding landscape, which enjoyed the views of the gardens and performed well thermally.

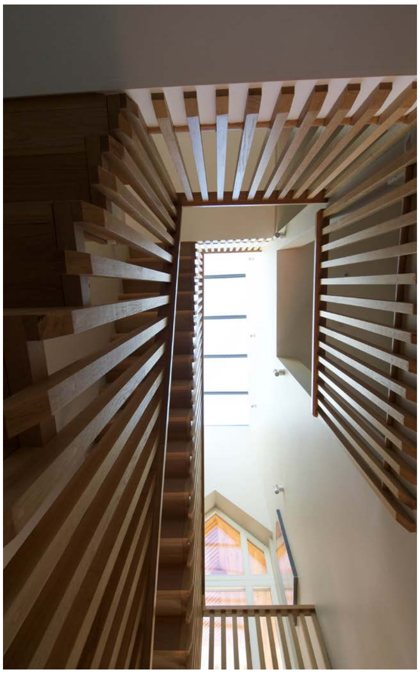
Our intent was to create strong visual links between the interiors and the landscape from each of the principal rooms, plus interconnecting views, which follow the landscape axis, between the interiors of the house. In order to maximise these views the floor plan was staggered along the central three-storey atrium space. This worked well for the layout and the connection with the landscape, but served to reduce the efficiency of the surface area to volume ratio.

A pair of traditional pitched roof house forms were overlapped, creating a three dimensional Venn diagram, where the overlap is the central heart of the house: the entrance atrium and stair. This overlap is expressed externally with a full dimension roof light, which serves to bring warmth into the house in the wintertime.

The entrance to the house supported a closing of the interior to the west elevation, which helped with summertime overheating, but views to the east of the site were crucial to the enjoyment of the interior spaces, so a careful balance of the shading had to be calculated. We also developed a wire structure to hang from the overhanging eaves which would support deciduous vine growth to prevent solar overheating in the summer, but would die back to allow welcome solar gain in the winter months. The ventilation design was carefully tweaked using PHPP with window opening sizes amended during the design process. The result was a reduction in summer overheating that meant the vine suspension system did not need to be fitted.

CONSTRUCTION IN PROGRESS

1 Oversite and blinding laid to prepare ground for hardcore base; **2** The PHI-certified Isoquick insulated foundation system eliminates any thermal bridges between the floor and walls; **3** Timber wall plates fixed to concrete slab perimeter, ready to connect the external wall timber frame panels; **4** Erection of the prefabricated timber frame system; **5** Corner opening in the timber frame for large Norrsken Passiv+ triple glazed alu-clad windows; **6** Ductwork for the large MVHR system through 400mm timber I-joist floor structure.



IN DETAIL

Building type: 420 sqm detached three-storey timber frame house, plus additional 110 sqm two-storey building w/ garage & housekeeper's annexe.

Location: Mayfield, East Sussex

Completion date: June 2015

Budget: £900,000

Passive house certification: Certified

Energy bill: £317 per year for space heating, not including hot water (calculated using space heating demand from PHPP and average cost of home heating oil and wood logs as published by www.confusedaboutenergy.co.uk).

Space heating demand (PHPP): 15 kWh/m²/yr

Heat load (PHPP): 11 W/m²

Primary energy demand (PHPP): 95 kWh/m²/yr

Airtightness (at 50 Pascals): 0.5 ACH

Energy performance certificate (EPC): B (86)

Heat loss form factor (PHPP): 2.47

Overheating (PHPP): 9.8%

Thermal bridging: Use of IsoQuick floor raft to enable thermal bridge free ground junction. IBO accredited details for panellised timber frame construction.

Ground floor: 250mm concrete slab on 350mm IsoQuick PHI-certified insulated foundation system.
U-value: 0.105 W/m²K

Walls: Factory-built timber frame with 22mm larch cladding externally, followed inside by 50x50mm treated battens, Protect TF200 windproof facade membrane, 9mm OSB board, 400mm Knauf Frametherm-filled I-joist timber stud, 15mm taped and sealed OSB-3, 50mm service cavity insulated with Knauf Frametherm insulation, and 12.5mm BG Gyproc Wallboard internally.
U-value: 0.0.87 W/m²K

Roof: Fibre cement slates externally on 50x35 battens/counter battens, followed underneath by Protect TF200 breathable membrane, 400mm timber I-joists fully filled with Knauf Frametherm, 15mm taped & sealed SmartPly OSB-3, 50mm service cavity insulated with 50mm Celotex, 12.5mm plasterboard ceiling.
U-value: 0.082 W/m²K

Windows: Norrsken Passiv+ triple glazed aluminium-clad timber windows, with argon filling and an overall U-value of 0.86 W/m²K

Roof window: Glazing Vision fixed triple glazed Flushglaze rooflight with solar control glass & Ritec easy clean coating.
Overall U-value: 1.0 W/m²K

Heating system: Grant Riello RDB 15-26kw oil fired condensing boiler serving 4 radiators and 6 towel radiators. 4kW Morso S11 90 wood burning stove.

Ventilation: Systemair SAV E VTC 700 Full MVHR. Passive House Institute certified heat recovery rate of 77%.

Green materials: All timber furniture from PEFC certified sources, material from demolition of existing house re-used in landscaping ground works. ■

SOUTH LONDON SCHEME DELIVERS

BETTER HEALTH FOR RESIDENTS

A sensitive development of social housing in Lambeth combines three new passive houses with six low energy flats delicately constructed inside an old Victorian terrace — and with the emphasis on good indoor air quality, residents are already reporting improvements in health & well-being since moving from their old accommodation.

by Kate de Selincourt

£99
(new build) &
£78 - £200
(retrofit)
per year for space heating only.

Buildings: Three new four-bedroom terraced passive houses & six low energy flats retrofitted into a Victorian terrace

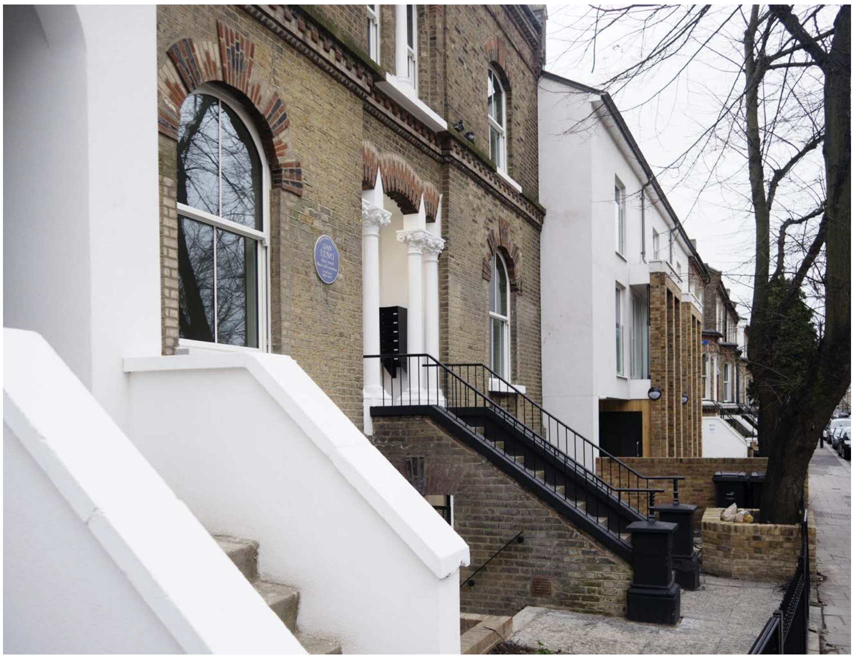
Standard: Certified passive new build & low energy fabric-first retrofit

Location: Akerman Road, Lambeth, London

Completed: December 2016

Total budget: £2m

Build method: Timber frame new build / deep retrofit with internal insulation to Victorian terrace.



Back in the spring, nine households received the keys to their new social-rented homes from Lambeth Borough Council. Three of these are new four-bedroom terraced houses, built to the passive house standard, and the first new social housing built by Lambeth council for ten years. The other six are low energy flats, carefully retrofitted into the two Victorian houses next door.

This development, on Akerman Road in the heart of the borough, is something of a mini shop window for Lambeth's much wider plan to redevelop its existing estates and build 1,000 new homes to tackle the acute housing shortage in the area.

But this was not the easiest site to develop. Sitting in a conservation area, one of the existing houses has a local listing. The Victorian houses also had to be completely reconfigured from their previous use as temporary hostel accommodation, while preserving the original façades.

The new dwellings, which re-connect the existing houses to their neighbours across a vacant bombsite, also had to meet strict visual criteria. And at the same time, the development needed to be completed within a realistic local authority budget, and be robust, easy to occupy and maintain. It also had keep the occupants safe, warm and free from large fuel bills.

The design was led by Anne Thorne Architects, who had worked with Lambeth on other redevelopments. But the project was a long time in gestation, Anne Thorne partner Fran Bradshaw explains: "The redevelopment was originally planned before the 2010 election, when the government was still spending on housing."

Even though there was only a small passive house movement in the UK at the time, the terraced form dictated by the site would enjoy a good form factor, which encouraged the architects to design to the standard.

For the new-build infill, the conservation authorities wanted to convey the height and grandeur of an adjoining 19th century house, and were initially unhappy about the look of the new designs with their level access, which was required for the Lifetime Homes standard. So Anne Thorne Architects added two-storey brick porches to echo the flights of steps to the Victorian entrances. These did add expense and complication, but look right in the location and helped to win planning permission.

The retrofit also prioritised energy performance. As Huw Jones, housing development manager at Lambeth Borough Council, puts it: "We particularly like the fabric-first approach because of its simplicity. It avoids relying on expensive technologies that require long term maintenance and replacement, which can add to tenant service charges."

However, having finally agreed a design with the planners and secured permission, progress stalled, and it was not until the planning permission was at risk of expiring that there was a window of opportunity to fund the build and proceed – so long as the team could get on site within four months.

In the intervening years the UK's passive house movement had expanded dramatically and Anne Thorne Architects had teamed up with a small group of design practices to form the 15:40 Collective, focusing on low energy fabric-first design to passive house and AECB building performance standards.

Anne Thorne Architects therefore enlisted the help of their colleagues in 15:40 to work up the design drawings to the highest performance standards while meeting the tight deadline. Everyone had to move fast. "With the very short time to get on to site, it was really good to have the 15:40 structure in place, to take on the construction designs for the retrofit and new build sides respectively," Fran Bradshaw says.

Anne Thorne Architects kept the reins overall. Meanwhile Prewett Bizley Architects took on the detailed design of the retrofit, and CTT Sustainable Architecture (since superseded by Passivhaus Homes Ltd) worked up Anne Thorne's designs into a fast-to-erect, passive house standard construction, using their own PH15 timber frame system.

New build

As Janet Cotterell of Passivhaus Homes explains, there was a pre-designed set of details, worked out carefully for minimal thermal bridging and ease of airtightness installation, so much of the design work had already been done. "We had all the details ready, they did not all have to be designed afresh for passive house, which would have been impossible in the time," she says.

"Having the pre-designed details de-risks the project and saves a huge amount of time and people's money. For me this is the really valuable thing about this construction system. It is such a waste of energy re-inventing the wheel each time."

"Especially for the trickier elements, we

were very careful about communicating the way the airtightness membranes were sequenced into the construction, and even sent some pre-cut and pre-taped corners for the carpenters to use," Cotterell adds. The strategy worked, and the fabric of the new houses passed the airtightness test comfortably at 0.4 air changes per hour at 50 Pascals. She believes carpenters are particularly well suited to passive house construction "because they are all about precision".

The Passivhaus Homes PH15 timber frame system is hygroscopic and vapour-open, increasingly so towards the outside of the build-up, where it is finished with a very open lime render. The nature of hygroscopic natural materials means a certain amount of moisture can be bound to the fibres in the materials in the solid phase – the material holds moisture but is not wet. This is different from the behaviour of impermeable materials, which might suffer condensation under the same conditions, and which might not disperse moisture so readily either.

"I think it is unwise to assume water will never get into a structure," Cotterell says, pointing out that no construction is perfect, and as the years go by, all buildings suffer damage and ageing. "The construction process may also allow some water in from the weather, and this needs to escape."

"We worry that impermeable construction solutions, coupled with timber frame, may be setting up a future problem down the line, and give timber building an undeserved bad reputation."

The retrofit

The detailed design of the retrofit was taken on by Anna Carton of Prewett Bizley. The two existing buildings had been in council possession for a long time, but had not undergone major works carried out since the 1980s. Described by the council as "generally habitable" the buildings were very 'tired' (or in council terminology, they had "significant asset liabilities"). And while some of the issues were already known, some only became apparent once work began. "The fabric was not in great condition: brickwork needed repair, there were roof leaks and damp in the basement, single glazed windows with rotten woodwork in the sashes and cills," Anna Carton recalls.

Despite the challenges imposed not only by the old and slightly ropey fabric, but also the conservation status of the buildings, the client wanted to carry as many of the benefits of passive house design as possible through to the retrofit. This meant using high levels of insulation, high-performance windows and doors, careful design to minimise thermal bridging, and the installation of heat recovery ventilation.

As Huw Jones of Lambeth council puts it: "Passive house design allows people to live their lives. They can dry laundry indoors without worrying about cold draughts, they won't suffer big energy bills."

But first the plans had to get the go-ahead. "Everyone in this area understands how challenging it is to work with conservation officers," Anna Carton says. "Getting agreement on the windows for example took about six months of going back and forth with different possible windows, and there were a number of objections, such as the thickness of the midrail, the drip details, etc. The Vrogrum sliding sash windows were finally accepted because they had the right curved heads."

"However just as important were the client's requirements for the windows to be lockable, easy to operate and easy to keep clean, and not exorbitantly expensive."

Meanwhile, new timber frame extensions to the rear for bathrooms and kitchens were insulated externally with Pavadry wood fibre insulation, but the front required internal insulation to preserve the street façade. Carton elaborates: "Timbers had been incorporated into the masonry by the Victorian builders, and as a couple of these at least were affected by dry rot, we removed them and repaired the bricks. We also cut away all the joist ends, parged the wall and then hung the joists away from the brickwork so they were out of capillary contact with the wall, which will be cooler and potentially damper after internal insulation."

Dampness in the basement appeared to be coming from groundwater, so the team lowered the ground level externally to the front and rear. This was not possible at the north façade, so a studded drainage membrane and French drain were installed here. Inside, the bottom 1.2m of the lower ground floor walls were lined with waterproof render and closed cell insulation. Above this, the insulation was breathable Pavadry wood fibre boards.

The team taped all joints in the internal

insulation to keep the warm indoor air away from the masonry – especially important as social housing can be quite densely occupied, with high moisture production.

To minimise thermal bridges, the insulation under the slab was turned up to meet the internal wall insulation, and the internal insulation was also returned inwards along party walls and up the basement partition walls to isolate the rooms from the ground.

Retrofitting a centralised mechanical ventilation with heat recovery (MVHR) system in an old building is tricky enough, but here, no duct terminals were permitted in the front façade, so some fiddly ductwork runs were needed that required false ceilings and ducts passing above staircases. Despite these difficulties, the team went ahead — the client wanted to share the benefits of good indoor air quality in all the dwellings. The MVHR will potentially save energy too, and the "cool recovery" function (when outdoor temperatures rise above indoor temperatures) should help with summer comfort.

Performance

Airtightness tends to be the biggest performance challenge when retrofitting an old building, and the finished retrofit here is less airtight than had been hoped — closer to 6.0 air changes per hour than the targeted 3.0.

"We suspect the issue may be at the interface between old and new structure at the back, which was quite tricky topologically. With all the parging and taping, we think the airtightness elsewhere was not too bad," Anna Carton says.

Different flats ended up with different energy consumption figures because form factors and solar gains vary. The aim was to get to around 40-45 kWh/m²/yr of space heating demand, but with the missed airtightness target the team couldn't get that low in all the units — the average is about 65 kWh/m²/yr.

Planning constraints potentially affected the performance of the new houses too, because of the requirement for tall façade windows in line with the neighbours."With all the glass on the front façade, we had to work hard to get the overheating down," Janet Cotterell explains. "With a combination of strategies like improved g-values and alterations to the window openings to enable more night ventilation, we managed to hold the overheating down to a figure 1.9% of hours above 25C in PHPP — allowable under passive house, but higher than we would ideally have liked."

The design and build style of the contract (common to social housing procurement in the UK) meant that not all the final details of the construction could be nailed down by the design team as closely as with a conventional contract.

Thus Prewett Bizley were not involved with the air-testing of the retrofit, so they weren't able to locate the weak points in the fabric. And a miscommunication about safety barriers meant that the purge ventilation openings on some windows in the retrofit are smaller than intended, though this is due to be resolved.

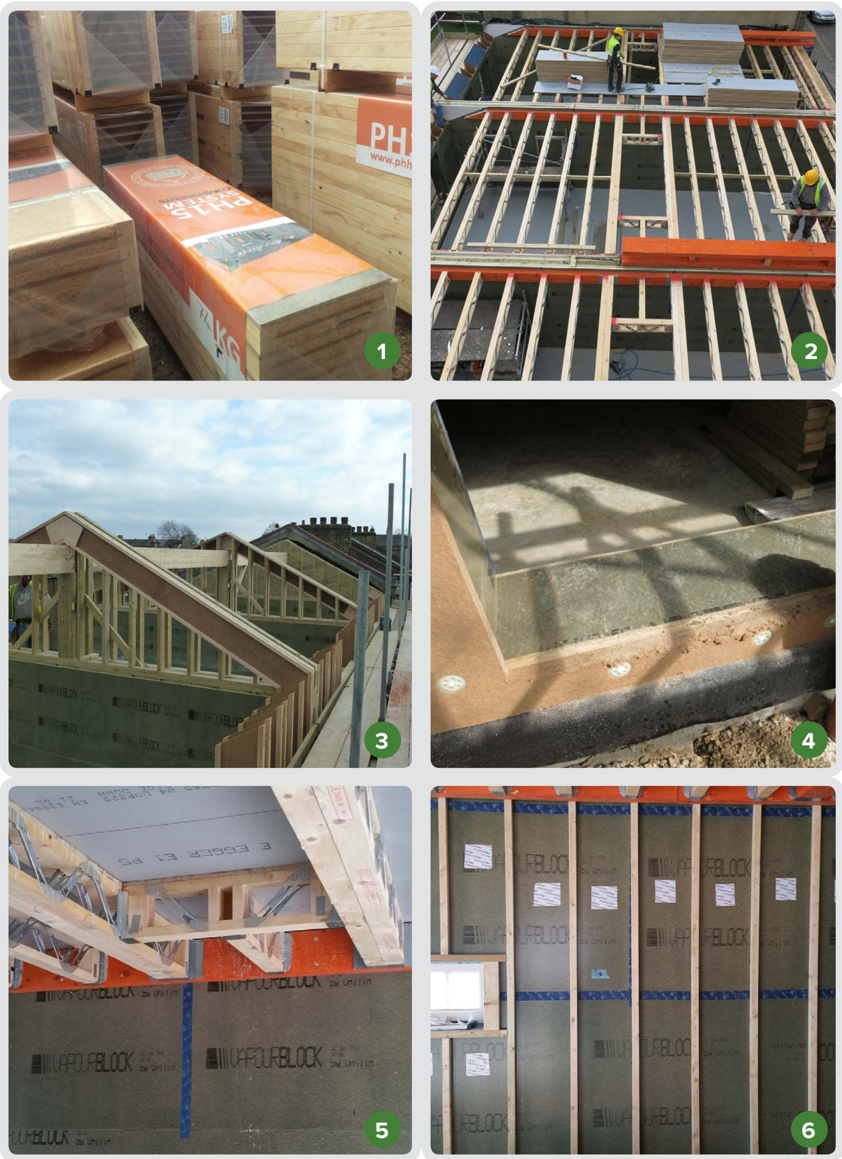
These kind of issues crop up quite frequently in design and build contracts, and 15:40 have now distilled their collective wisdom into procurement advice to social housing clients intending to build high quality, high performance homes.

They advise clients to ensure there is independent (from the main contractor) post-tender quality control on site, delivered by someone with good energy-efficiency knowledge, who reports directly to the client.

Handover

Occupants were taken through the ins and outs of their new homes at the time of moving in. Anne Thorne Architects is now working with a PhD student from University College London on a two-year post occupancy study, looking at energy use and bills, indoor air quality (CO_2, humidity) and the perceptions of both residents and landlord. The post occupancy evaluation team found on the first visit, three months after occupants had moved in, that things still needed some explaining and adjusting.

CONSTRUCTION IN PROGRESS



1 The PH15 timber frame system delivered to site — this low embodied energy timber frame system is both breathable and vapour permeable; **2** Metal web joists to the timber frame for neat installation of services; **3** Roof joists fixed to load bearing I-joist walls using 18mm plywood gussets; **4** Cross section of the PH15 timber frame system showing cellulose insulation internally with wood fibre outer skin, which forms the base for the Lime Green Warmshell render; **5** Metal web joists to ceiling with taped Durelis Vapour Board to all internal walls for airtightness and vapour control; **6** Studwork for service cavity to the inside of the airtightness layer, with tape over penetrations where the Thermofloc cellulose was pump-installed.

Photography: Paul Samuel White

> SINCE WE'VE BEEN HERE, SHE DOESN'T COUGH IN THE NIGHT.

SELECTED PROJECT DETAILS

Client: London Borough of Lambeth Council
Architect (pre-planning): Anne Thorne Architects
Architect (post-planning) & passive house design: 15-40 Collective
M&E engineer: Alan Clarke
Civil & structural engineer: Ellis & Moore
Passive house certification: Warm
Project management: Artelia UK
Main contractor & mechanical contractor: Sandwood
Quantity surveyors: Peter W Gittins & Associates
Electrical contractor: PA Electrical
Airtightness tester: Encraft
Timber frame system & MVHR: Passivhaus Homes
Airtightness products: Green Building Store
Windows & doors (new build): Passivhaus Store
Double glazed sliding sash windows: Vrogum
Flooring: Hillingdon Flooring
Planting: Acacia Gardens
Drainage / paving: Connellys
Wood fibre insulation (retrofit): Natural Building Technologies

This is far from unusual —on moving day new occupants are usually preoccupied, and people tend not to absorb everything in one go anyway. Quite often the first visit in a post-occupancy evaluation or 'soft landings' process ends up being an extension of the handover. Arguably, landlords and developers should accept this as routine.

"Lambeth have been very good about this, they appreciate the importance of improving the handover process, particularly for explaining the importance of the ventilation and how to use it," Fran Bradshaw reports.

All nine of the households have now been interviewed and asked about their experience. Comments are generally very positive — occupants like the warmth, the space, and the garden with its mature trees and room to grow vegetables.

Residents were also asked specifically about their health, and whether anyone in the household suffered respiratory problems.

In four households, at least one occupant suffered from asthma or other lung problems. Remarkably, all of these households reported that symptoms had improved. There was less need for medication, they reported, and one household reported that a child's asthma had not been problematic at all since the move.

One mother commented: "My baby daughter had patches on her lung ... You could hear the raspiness in her cough, and a constantly runny nose. She doesn't suffer from that anymore — since we've been here, she doesn't cough in the night."

While this is a very small sample, it gives a tantalising glimpse of just what might be achieved if we built and renovated our housing stock explicitly around everyone's need for a healthy home. Lambeth Council are certainly keeping an eye on the findings with interest.

"Health is not a specific factor on our housing needs register, but we are responsible for public health as a borough, so it makes sense that this is something we can do long-term for health," says Huw Jones.

"There is anecdotally a link here to good health. It would be nice to be more scientific about this — we are hoping that the post occupancy evaluation information and monitoring we are collecting will help us."

Will Lambeth go passive again?

Council members are very enthusiastic about the new homes and the benefits they bring, Jones says. "They are really keen to drive this quality across our wider programme to help address important issues such as fuel poverty, high bills, indoor air quality and health.

"However there are challenges in delivering larger projects to the [passive house] standard, including cost, building form, and contractor experience, so we are taking a methodical approach to ensure appropriate solutions across our programme.

"We have written a design guide with a set of principles that includes some targets, including indoor air quality. The post occupancy study on the Akerman scheme will hopefully help us to inform future work."

Despite achieving passive house with the new build, these houses didn't break the budget – mainly, Jones believes, because they designed in high performance from the outset.

This echoes the advice from Anne Thorne Architects, who have been helping Lambeth with their strategy for the 1,000 new homes they want to deliver in the borough. "We have been encouraging Lambeth to go for it and build to passive house — but we have stressed that they really do need to be clear that is the goal, and ensure everyone is signed up, right from the start of any project," Fran Bradshaw says.

Meanwhile, Huw Jones certainly wants to share the benefits they have achieved at Akerman Road across all of their new housing stock. "I think social landlords are the ideal organisations to take up this method of building and prioritise it," he says."We've got a long-term interest in the stock, and a responsibility for everyone's well-being."

CONSTRUCTION IN PROGRESS



1 The original timber rafters in the roof of one of the retrofit dwellings, with Pavadry wood fibre internal insulation up against an existing masonry gable wall, and new windows installed; **2** Pavadry wood fibre internal insulation fully taped here for airtightness using pro clima Tescon tapes and returning along party wall to reduce thermal bridging, with new Vrogum window also visible; **3** Intello membrane and Tescon taping with MVHR radial ductwork system poking through.

IN DETAIL: NEW BUILD

Building type: Three 136.5 square metre three-storey timber frame terrace houses.

Passive house certification: Certified January 2017

Space heating demand (PHPP): 15 kWhm^2/yr

Heat load (PHPP): 9 W/m^2

Primary energy demand (PHPP): 103 kWh/m^2/yr

Heat loss form factor (PHPP): 1.8

Airtightness (at 50 Pascals): 0.34, 0.39, 0.4 ACH

Overheating (PHPP): 1.9 % (of time above 25C). No opportunity for Brise Soleil in this London location with sensitive planning issues. Overheating study carried out and as a result lower g-value glass added to the front elevation, increased top window frame thickness (so night cooling could be enhanced in tilt position), and added demand control on the MVHR systems.

Energy performance certificate (EPC): B (88 or 89) for all three units (Note: the architects stress these figures are unlikely to reflect the true energy performance due to use of various assumptions / defaults).

Thermal bridging: Houses are built using the PH15 passive house suitable timber frame system from Passivhaus Homes. PH15 details for all principle junctions: wall to slab detail 0.004 W/mK, intermediate floor to wall thermal bridge free, eaves detail 0.003 W/mK, roof ridge detail -0.006 W/mK.

Energy bills (measured or estimated): Estimate of £99 per year for space heating only (based on PHPP data & gas price of 4.3p per kWh).

Ground floor: Ground bearing slab of 150mm thick reinforced concrete on 1200 gaugepolythene Radon membrane, on 200mm Celotex GA4000 (Lambda value of 0.022 W/mK), on sand blinded and compacted hardcore. Power floated finish to slab, target +/- 3mm level tolerance to take pre-cut timber frame. U-value: 0.109 W/m^{2}K.

Substructure blockwork walls with 150mm cavity, fully filled with insulation, thermal break using two courses of Foamglas Perinsul blocks in inner leaf.

Walls: 360mm Steico I-joists at 400mm centres with 360mm wide timber floor plate. Wall void fully filled with Thermofloc cellulose insulation. Sole plate screwed to concrete slab and outer leaf blockwork on DPC. Timber lintels generally C24 softwood. 12mm Spanotec Durelis Vapour board to inner face of all walls with 4mm expansion gap at edges. All joints taped with pro clima Tescon Vana to form combined racking, vapour check and airtightness layer. All service penetrations fitted with pro clima Kaflex or Roflex airtightness grommets. 40mm of Steico Protect wood fibre insulation to outer face of timber frame (Lambda value of 0.049 W/mK) using Ejot thermally broken insulation fixings. Finished externally with Lime Green Warmshell render system.
Overall U-value of 0.112W/m^{2}K.

Roof: 360mm deep Steico I-joists at max 400mm centres with a maximum span 5890mm. Roof void fully filled with Thermofloc cellulose insulation. Roof joists fixed to load bearing I-joist walls using 18mm plywood gussets, fixed to webs (gussets also used at roof ridges). Lintels to rear elevation using bespoke timber box lintels supplied as part of PH15 System. Roof ridge beam Ultralam R LVL beams. Intello Plus vapour control and airtightness membrane on underside of roof fully taped at all joints with Tescon Vana airtightness tape and taped to Spanotech wall airtightness layer. 40mm of Steico Special Dry wood fibre insulation to outer side of roof (Lambda value of 0.041W/mK) using Ejot thermally broken fixings. Solitex Plus roofing membrane with taped joints. Reconstituted slate roof externally. U-value: 0.108 W/m^{2}K.

Party wall: Plasterboard skim externally followed inside by 25mm service void if needed, 12mm Spanotec Durelis board (airtight / vapour block), 18mm Fermacell board, 97x47mm studs + 60mm gap + 97x47mm studs (all fully filled with mineral wool insulation to 254mm), 18mm Fermacell board, 12mm Spanotec Durelis board (airtight / vapour block), 25mm service void if needed, plasterboard and skim.1 hour fire rating. U-value: 0.137 W/m^{2}K.

Windows, external doors and patio doors: All windows and doors Katzbeck Massiva, all wood stained / painted and triple glazed. Tescon Profil airtightness tape. Windows minimum overall U-value of 0.8 W/m^{2}K and class 4 airtightness rating.

Heating system: Vaillant Ecotec Plus 837 gas combi boiler, SEDBUK (2009) 89.3%.

Controls: Vaillant time switch 150 to control heating, Vaillant VRT room thermostat in living room.

Radiators: Stelrad concord slim column radiator in living room with lockshield valves, heated towel rails in bathrooms with TRV control.

Ventilation: Brink Renovent Excellent 400MVHR, PHI certified heat recovery rate of 84%, with radial ducting system (ie. supply or extract ducts direct to each space from a distribution box). Semi-rigid circular ducts (diameter 75mm) generally running within Eco-Joist floor voids to wall mounted outlets. Main unit located within second floor cupboard off landing.

Water: Water butts in gardens.

Green materials: Cellulose insulation and all timber from PEFC certified sources. PH15 is a low embodied energy construction solution, and is both breathable and vapour permeable.

Architect Fran Bradshaw interviewing one resident of Akerman Road as part of her post-occupancy evaluation survey

IN DETAIL: RETROFIT

Building type:
Three and four-storey Victorian townhouses. Solid masonry, with timber intermediate floors and roof. Concrete basement. Retrofitted with four flats (34, 66, 82 & 86.5 sqm) at No 56 and two flats (52 & 60 sqm) at No 58.

Space heating demand (PHPP):
Before: Estimated to be >150 kWh/m^2/yr.
After: Average of 49 kWh/m^2/yr (No 56) & 65 kWh/m^2/yr (No 58).

Heat load (PHPP):
Before: Unknown.
After: Average of 28W/m^2 across all six flats.

Primary energy demand (PHPP):
Before: Estimated to be in excess of 300 kWh/m^2/yr.
After: Avergage of 110 (No 56) and 120 kWh/m^2/yr (No 58).

Heat loss form factor (PHPP):
Average of 3.0 across all six flats.

Energy bills: Estimated to range from £78 (for the smallest flat) to £200 per year (for the largest) for space heating only (using PHPP data and gas price of 4.3p per kWh).

Energy performance certificate (EPC):
Range from C (77) to B (82) (Note: the architects stress these figures are unlikely to reflect the true energy performance due to use of various assumptions / defaults).

Airtightness (at 50 Pascals):
Before: Approx 20 ACH for each building.
After: 4-5 m^3/h/m^2 (No 56) and ~6 m^3/h/m^2 (No 58).

Walls:
Before: Solid masonry with gypsum or sand / cement plaster internally. U-Value: ~2 W/m^{2}K.
After: Solid masonry with Baumit Speedfil & Baumit RK38 hydraulic lime plaster applied to inside, followed inside by 92.5mm Pavadry internal wood fibre insulation (fully taped using Tescon tapes), services void, British Gypsum plasterboard. U-Value: 0.36 W/m^{2}K.

Extension walls (No 56): Timber frame with mineral wool insulation, followed outside by 60mm Pavatherm Plus wood fibre, ventilation void, single brick skin rain screen. U-Value: 0.16 W/m^{2}K.

Roof:
Before: Natural slates on battens on bituminous sarking membrane, on 100mm timber rafters. Some mineral wool at ceiling level. U-Value: ~0.6 W/m^{2}K.
After: Warm roof sections: Reclaimed and new slates on battens and counter battens, on 150mm rafters with 150mm Pavaflex between, on 60mm Pavatherm Combi, on 15mm service void and plasterboard. U-value: 0.13 W/m^{2}K.

Cold roof sections (No 58 only): 250mm cellulose insulation over 18mm OSB to ceilings. U-value: 0.18 W/m^{2}K.

Extension roof (No 56 only): Single ply roofing membrane (contractor specified) over 150mm PIR insulation, over VCL, over plywood deck, over 150mm joists with mineral insulation between, over suspended ceiling. U-value: 0.13 W/m^{2}K.

Floor:
Before: Concrete with slab over.
After: Laminate floor over 40mm Anhydrite screed over VCL over 150mm Jabloor EPS (to No 56) or contractor specified vacuum insulated panels (to No 58), over 150mm concrete slab. U-value: 0.2 W/m^{2}K.

Windows:
Before: Single glazed, timber frames sliding sashes and casements. Approximate U-value: 3.50 W/m^{2}K.
After: Vrogum double glazed sliding sash windows and Katzbeck Massiva tilt and turn windows. Overall U-value of 1.5 W/m^{2}K.

Heating system
Before: Unknown.
After: Vaillant Ecotec Plus 831, 91.1% efficiency according to SEDBUK. Vaillant time switch 150 & combisave on hot water outlet. Stelrad radiators and tower radiators.

Ventilation:
Before: Through wall vents in bathrooms and kitchen areas.
After: Brink Renovent Excellent 300 MVHR to all units except one flat which has a Brink Sky 150. Both PHI certified with heat recovery rate of 84%. Radial duct distribution system with Ubink distribution boxes and ducts and Lindab silencers.

Green materials: Wood fibre insulation, re-used slates, all timber from PEFC certified sources.

A1 PASSIVE HOUSE OVERCOMES

TIGHT CORK CITY SITE

Designing a dwelling to take advantage of the sun's free heat is a big part of what makes a passive house passive. So how do you meet the low energy standard when your narrow site faces away from the sun and is overshadowed by neighbouring houses and trees, while simultaneously hitting an A1 building energy rating – and with a stunning, architecturally expressive design?

by John Cradden

€224
annual estimated heating costs

Building type: 323 sqm detached blockwork house

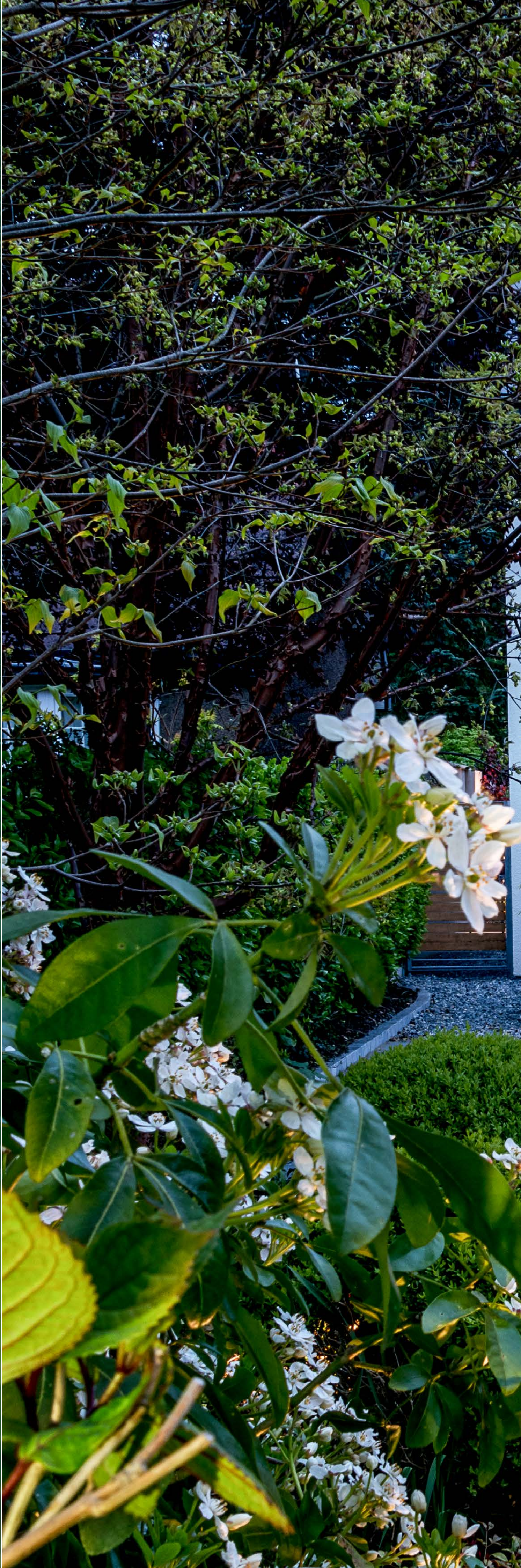
Completed: September 2016

Location: Cork City

Build method: Concrete block with external insulation

BER: A1

Standard: Certified passive house



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This new home in Cork City shows how to meet the passive house standard on a narrow and tight site with unusually poor solar gain. The property was previously home to a two-storey dwelling with several extensions, and the client, who wishes to remain private, initially hired Wain Morehead Architects to renovate it.

But the internal spaces of the old house were poorly organised, and the client ultimately decided to knock it in favour of a new, energy-efficient, bright and modern house. Wain Morehead is one of Ireland's leading passive house design practices, so it's no surprise they ultimately decided to aim for that standard here.

"We wanted to be confident that whatever design standard we chose had a track record and would deliver not just in terms of design, construction and performance, but also in terms of the quality of all the elements of our home," says the client.

However, good solar gain is a key part of reaching the passive house standard — and there were big problems getting enough here. The long and narrow site is overshadowed to differing degrees by dwellings on three sides, as well as by mature trees. The site also faces north-east, and is bounded with 2.4m-high walls that obscure any low-lying sun.

What architects John Morehead and Jennifer Kenefick came up with was a design comprising two double-storey sections connected by a single-storey link. The building wraps around an internal courtyard that takes advantage of the sun at all times of the day, making use of the site depth while acknowledging existing building lines. The path of the winter sun through the sky was used to guide the trimming of trees along the southeast boundary, helping to optimise solar gain.

The finished design aims to balance light, connectivity of the internal spaces and integration with the surrounding landscape, while maintaining privacy. However, the project was held up during the planning process, and planning permission had to be appealed. This delayed construction and required the architects to re-design the rear of the house, reducing its width and changing the internal layout, but also compromising solar gain to this part of the dwelling.

The overall lack of solar gain meant the building fabric needed even more insulation to meet passive house targets for space heating demand. This was provided by walls of Quinn Lite blockwork externally insulated with 250mm of Kingspan Aerowall graphite-enhanced EPS, a Kore insulated foundation system, and a warm roof system

> THE PATH OF THE WINTER SUN THROUGH THE SKY WAS USED TO GUIDE THE TRIMMING OF TREES ALONG THE SOUTHEAST BOUNDARY.

66

THE BUILDING WRAPS AROUND AN INTERNAL COURTYARD THAT TAKES ADVANTAGE OF THE SUN AT ALL TIMES OF THE DAY.

– filled with cellulose insulation from local manufacturer Ecocel – with wood-fibre sarking insulation.

The environmental impact of the concrete in the foundations was reduced in two ways. Firstly, as insulated foundation supplier Kore explain, the use of an insulated raft foundation can reduce the quantity of concrete used by up to 50% compared to a strip foundation. Secondly, the concrete included ground granulated blast furnace slag (GGBS) – a by-product of the steel industry that can replace portland cement use up to high percentages – 66% in this case – leading to substantial carbon dioxide emissions reductions in the manufacturing process. Roadstone - who supplied the GGBS in this case - don't publish embodied CO2 figures on their GGBS. Had the GGBS come from Ecocem, who do, the net effect would have been a reduction of some 4.5 tonnes of CO_2, equivalent to preventing a typical passenger car driving for almost 37,000 KM.

The concrete construction also extended to the first floor, with precast concrete slabs and stairs. This made it somewhat challenging for the architects to maintain airtightness around the slabs, and to integrate the precast concrete staircases. However, contractor Brian Twomey of Michael Twomey & Son is a certified passive house consultant and was ultimately able to get the finished house just inside the target of 0.6 air changes per hour.

The other big challenges, according to John Morehead, included access to and around the narrow site, the difficulty of fixing into the lightweight blocks, and the amount of time needed to allow the wet trades to dry out.

The finished house is primarily heated via

Photography: Gabrielle Morehead Photography

supply air by a Nilan Compact P unit, which includes an exhaust air heat pump combined with passive heat recovery ventilation, with back-up coming from a Nilan Air 9 air-to-water heat pump, which distributes heat via underfloor heating only during the coldest winter periods.

The client says: "The biggest change for us is that there has been very little forced heat or cooling input. It wasn't unexpected, but the uniformity of temperature throughout the house is a pleasant surprise, and the fact that we don't constantly have to turn boilers on or off or adjust thermostats is great."

The architects are now monitoring the house for its energy consumption, indoor humidity, carbon dioxide, temperature, and for the energy production of the solar PV array. The house was also recently commended at the 2017 RIAI Architecture Awards in the sustainability category.

Explained:

Passive solar gain is the term used to describe 'free' heat energy from the sun. In the northern hemisphere, architects can design buildings to take advantage of solar gain by orienting the main glazed surfaces to the south. Maximising solar gain is a key element of passive house design. However, designing for solar gain must be balanced with the risk that lots of south-facing glazing can lead to overheating and uncomfortable glare in summer.

SO HOW IS THE HOUSE PERFORMING?

Since the clients moved in, Wain Morehead Architects have been monitoring indoor temperature, humidity and CO_2 at two locations in the house, as well as the dwelling's overall energy demand, and the generation of the solar PV array.

While technical difficulties have interrupted monitoring, there is a complete set of data available for February 2017. One of the monitoring modules, located in the highly-insulated but little-glazed northern part of the house, shows indoor temperatures remaining remarkably even at around 22C, with little difference between maximum and minimum daily temperatures, bar a couple of spikes — the largest of which came on Feb 22, though the clients cannot recall exactly what might have caused this.

Relative humidity generally remained between 45% and 55% (40% to 60% being the recommended indoor range), with CO_2 ranging between 500 and 900 parts per million, suggesting good indoor air quality. CO_2 only peaked over 1,000ppm on February 22.

The overall energy demand was 5.6 kWh/m²/yr for the month of February, equating to 67.45 kWh/m²/yr for a full year if February is an average month — close to the primary energy demand of 65 kWh/m²/yr as calculated in PHPP. While the solar PV array only produced 89.63kWh for all of February, this increased to 176.47 kWh in April. Overall energy demand declined to 4.22 kWh/m² in April (or 50.61 kWh/m²/yr, if April is used as an average month).

"We are extremely pleased with the CO_2 levels and temperature stability within the dwelling during both of these periods," says architect Jennifer Kenefick. "The lack of solar gain and robust envelope performance is very apparent in the 'indoor remote module' temperature results, located in the northern section of the house."

She added that in May, it was found a circulation pump in the underfloor heating circuit was operating permanently, even though there was no heating demand. A software upgrade is expected to address this issue and further reduce energy demand.

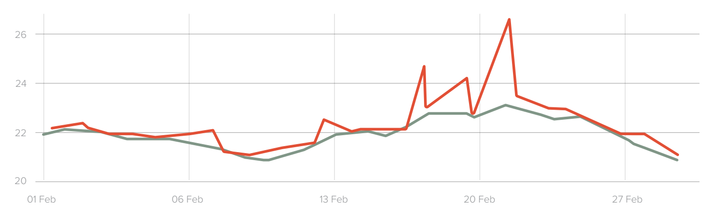
"Our early monitoring in the autumn of last year, identified a shut down in the ventilation system that had taken place after a power failure when the building was not occupied. Monitoring is extremely useful during the drying out, handover and commissioning periods."

But how has the house been performing in the warm weather in June and July? In June the exterior temperature in the courtyard peaked at 27.2C at 3pm on 19 June. The highly glazed kitchen area peaked at 26.3C that evening, and average temperatures in the kitchen remained above 25C for just over a week. Meanwhile the remote monitor in the northern block – which is highly insulated but with very little glazing – peaked at 23C on 19 June.

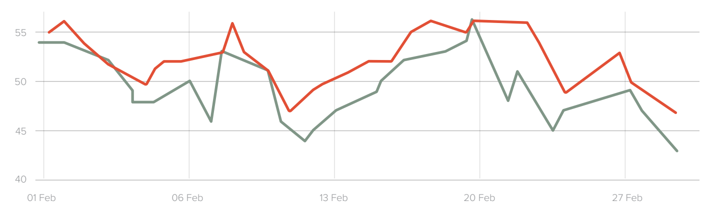
"The remote station in the northern block is extremely stable," says John Morehead. "The kitchen is more volatile but dumps heat as the high level windows open and as the client wishes."

MONITORING GRAPHS

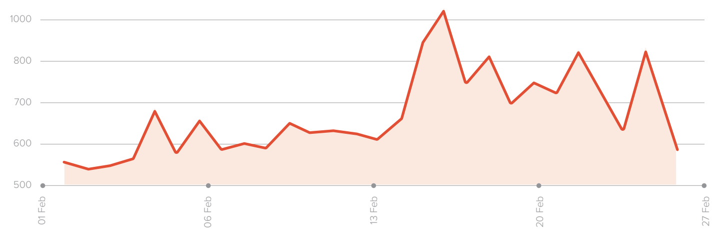
TEMPERATURE - INDOOR REMOTE



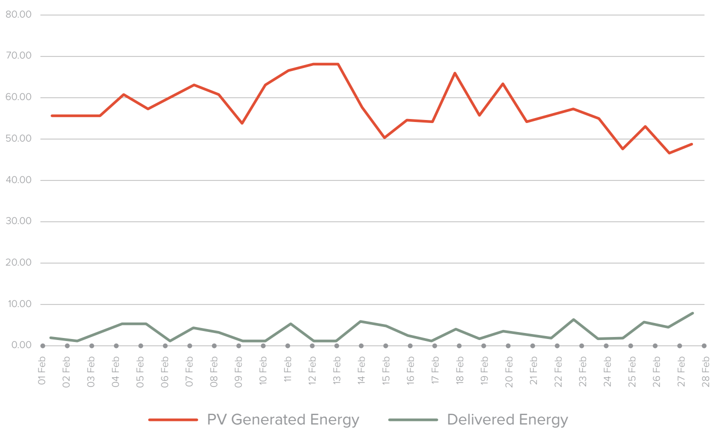
HUMIDITY - INDOOR REMOTE



CO_2 - INDOOR REMOTE



DELIVERED & GENERATED ENERGY FEB 2017



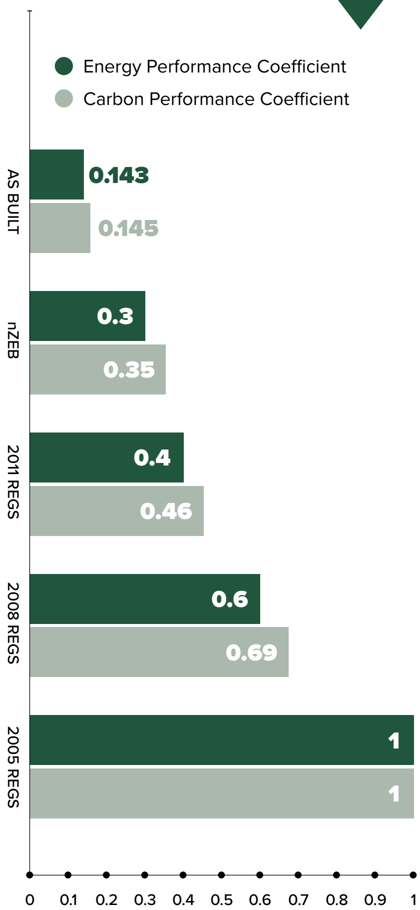
CONSTRUCTION IN PROGRESS

1 The ground floor features a raft foundation consisting of 300mm Kore EPS300 insulation and radon barrier; **2** Primary space heating and ventilation is provided via the Nilair ventilation ducting system; **3** The floor build-up also features a layer of 80mm Kingspan TF70 insulation boards that also contains ventilation ductwork channels; **4** Secondary space heating is provided by a Nilan Air 9 air-to-water heat pump via zoned underfloor heating; **5** The walls of the house are insulated externally with 250mm of Kingspan Aerowall platinum EPS; **6** Frame for the Gyproc suspended ceiling system, for housing of services within the airtight layer, at the kitchen light-well.

Explained: The ***Energy Performance Coefficent (EPC)*** and ***Carbon Performance Coefficient (CPC)*** measure the energy and carbon efficiency of buildings under the Irish building regulations. Here we compare the EPC and CPC for this dwelling to Ireland's proposed nZEB standard and to the current (2011) and past versions of Part L of the Irish building regulations. The lower the fraction, the better the score - so for instance a house with an EPC of 0.4 is 60% better than the 2005 regs.

SELECTED PROJECT DETAILS

Architect: Wain Morehead Architects
M&E engineer, heat pump and ventilation: Nilan Ireland
Civil & structural engineer: Allen Barber Consulting Engineers
Passive house certifier: Mosart
Main contractor: Michael Twomey & Son
Quantity surveyor: Richard Leonard & Associates
Landscape design: John Butler Landscaping
Mechanical contractor & airtightness tester: Energywise Ireland
Electrical contractor: Owers Electrical
Audiovisual controls: Future Homes
Airtightness testing: Clean Energy Ireland
Cellulose insulation: Ecocel
Wood fibre insulation & breather membrane: Ecological Building Systems
Floor insulation: Kore
Wall insulation & additional floor insulation: Kingspan
External insulation system: Baumit
Airtightness system: Siga
Windows & doors: Smartwin
Roof windows: Velux
Curtain walling: AMS
Curtain walling installation: 20/20 Glazing
Zinc cladding: Weatherseam
Dry lining: Fermacell
Lightweight concrete blocks: Quinn Lite
Radiators: ATC
Solar PV: Sharp
Monitoring station: Netatmo
Floor screed: Smet
Timber flooring: Junckers
Kitchen and fitted furniture: Classic Kitchens Carrigaline
Sanitaryware: Irish International Traders Cork / Eden Tiles & Bathrooms
Lighting: Erco Lighting Ltd / Cork Lighting
Lighting controls: Legrand / Future Homes
Heating controls: Nilan / Heatmiser
Low energy appliances: Neff, Bosch, Samsung
Roof slates: Burlington Stone
Slate internal thresholds, window boards & countertops: Ceco Products, using slate via Burlington Stone
Rainwater harvesting: Ireland Waste Water
Paints: Dulux
Slate: Lagan Building Solutions
GGBS: Roadstone



IN DETAIL

Building type: 323 sqm (287 sqm TFA) detached two-storey externally insulated blockwork house.

Space heating demand (PHPP): 14 kWh/m²/yr

Heat load (PHPP): 8 W/m²

Primary energy demand (PHPP): 66 kWh/m²/yr

Heat loss form factor (PHPP): 3.88

Overheating (PHPP): 3% (of time indoor temp greater than 25C)

Energy performance coefficient (EPC): 0.143

Carbon performance coefficient (CPC): 0.145

BER: A1 (22.23 kWh/m²/yr)

Heating costs: €224 per year estimate, based on PHPP calculated figure of 1602 kWh/yr at an electricity price of 0.014c per kWh.

Thermal bridging: Externally insulated Quinn Lite blockwork walls, all junctions thermally modelled, all external structural elements thermally isolated from thermal envelope, insulated raft foundation, thermally broken window frames & all window reveals insulated, first two courses of Quinn Lite blocks to all internal blockwork walls. Y-value (based on ACDs and NSAI certified details): 0.0342 W/m²K

Ground floor: Raft foundation consisting of 300mm Kore EPS300 insulation, followed above by 200mm concrete containing 66% Roadstone GGBS, 80mm Kingspan TF70 (containing ventilation ductwork), 50mm Smet Fast Floor hemihydrate screed with solid oak floor finish. 50mm Kingspan TF70 perimeter insulation. U-value: 0.08 W/m²K

Primary walls: Baumit NanoporTop external insulation composite system including 18mm weathertight render on 250mm Kingspan Aerowall insulation on 215mm Quinn Lite B7 block on the flat, on 15mm internal plaster (airtight layer). U-value: 0.11 Wm²K

Dormer cheek: Standing seam zinc cladding followed inside by Tyvek Metal Underlay, 18mm SmartPly ToughPly, 50x38mm battens, pro clima Solitex Plus membrane, 60mm Gutex Ultratherm, 18mm OSB 3, 225mm timber with full fill Ecocel insulation, 18mm OSB 3, Siga Majpel vapour control layer, 20mm service cavity, Fermacell board. U-value: 0.14 W/m²K

Pitched roof: 500x300mm Blue Bangor roof slates externally, followed inside by 50x35mm slating battens @205mm c/c, 50mm counter battens, Solitex Plus roofing membrane, 60mm Gutex Ultratherm, 225mm rafters with full fill Ecocel insulation, 18mm OSB 3, Siga Majpel vapour control layer, 50mm service cavity with Rockwool Flexi, Fermacell board. U-value: 0.13 W/m²K

Zinc roof: Standing seam zinc roof cladding externally, followed inside by Tyvek metal underlay, 18mm SmartPly ToughPly, 50x25mm battens @260mm c/c, 50mm counter battens, pro clima Solitex Plus roofing membrane, 60mm Gutex Ultratherm, 225mm rafters with full fill Ecocel insulation, 18mm OSB 3, Siga Majpel vapour control layer, 50mm service cavity with Rockwool Flexi, Fermacell board. U-value: 0.13 W/m²K

Windows: Pro Passivhausfenster GmbH SmartWin passive house certified triple glazed aluminium-clad timber windows, with argon filling and an overall U-value of 0.7 W/m²K

Roof windows: Velux GGU-K-0082230 triple glazed, krypton-filled roof window, PHI certified, overall U-value: 0.7 W/m²K. Carey Glass patent glazing system over pantry, krypton filled, glazing U-value: 0.4 W/m²K

Heating system: Primary space heating is provided by the Nilan Compact P air-to-air heat pump & passive ventilation system via NilAIR ventilation ducting system. Secondary space heating is provided by a Nilan Air 9 air-to-water heat pump (external) unit via zoned underfloor heating during coldest weather. There is a 180L domestic hot water storage tank heated by the Compact P by utilizing exhaust air, while a 250L pre-heating hot water storage tank is heated by the Air 9 only when hot water demand is high. The Compact P can also provide additional cooling, with hot water generated as a by-product.

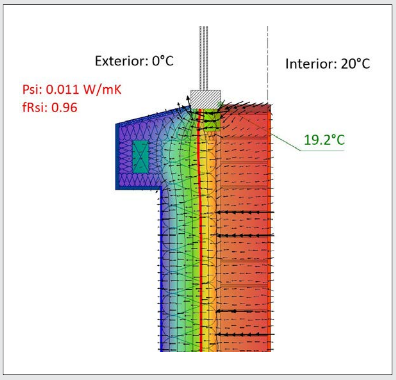
Ventilation: Nilan Compact P with Nilan Air 9 air-to-water heat pump. Compact P providing mechanical ventilation with heat recovery. Passive House Institute certified.

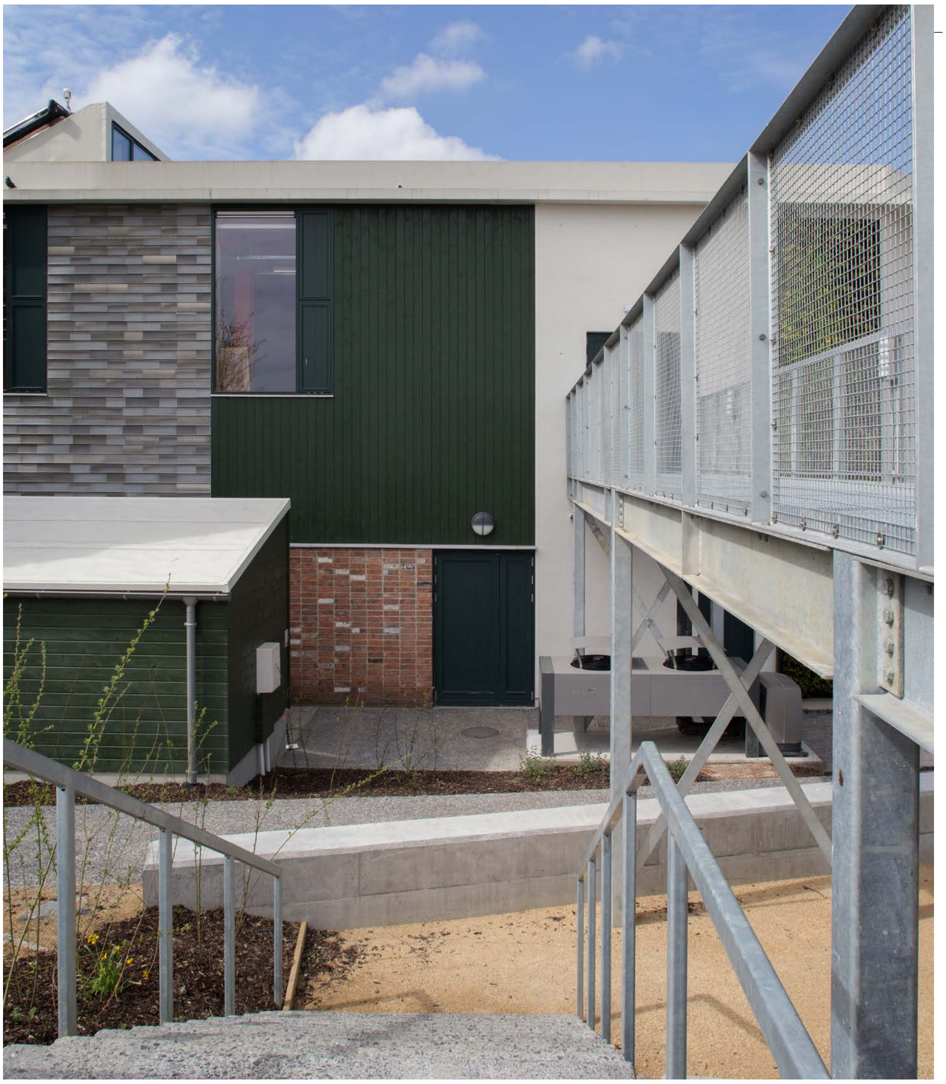
Electricity: 8 x 250Wp solar photovoltaic panel array with average annual output of 2kW.

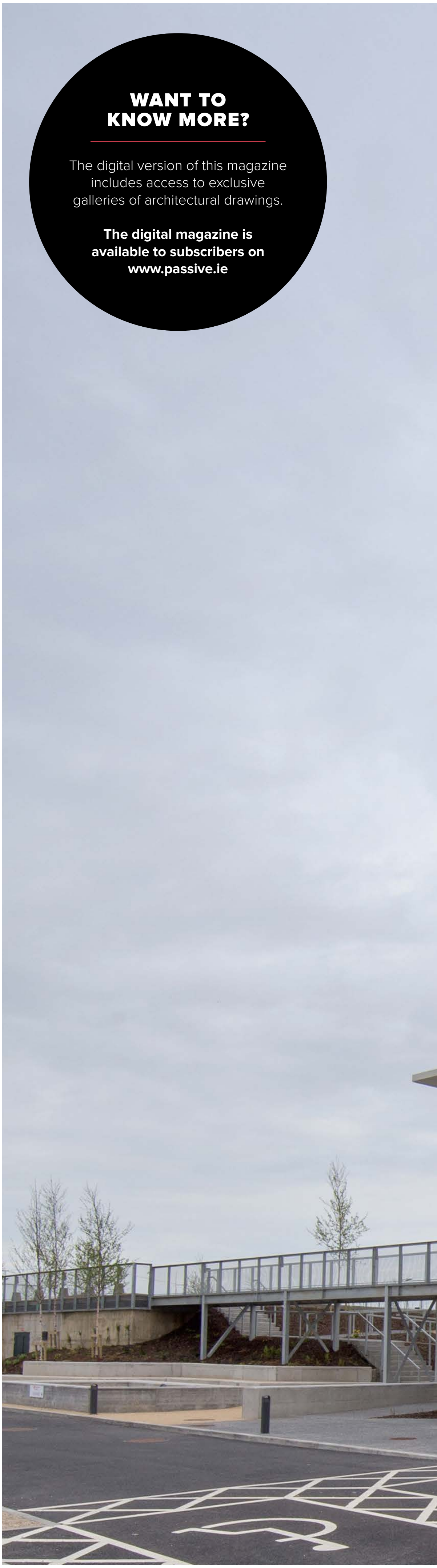
Lighting: Low energy LED lighting throughout. Generally, Erco LED wallwashers, Starpoint downlighters / spotlights. Exterior lighting integrated with overall lighting design.

Green materials: Fermacell dry lining board, Ecocel insulation, Gutex Insulation, all timber from PEFC / FSC certified sources, 66% GGBS cement, Rockwool insulation, low VOC paints.

Water conservation: Euro Rainwater Harvesting System with 1250L concrete tank to supply non potable water uses.







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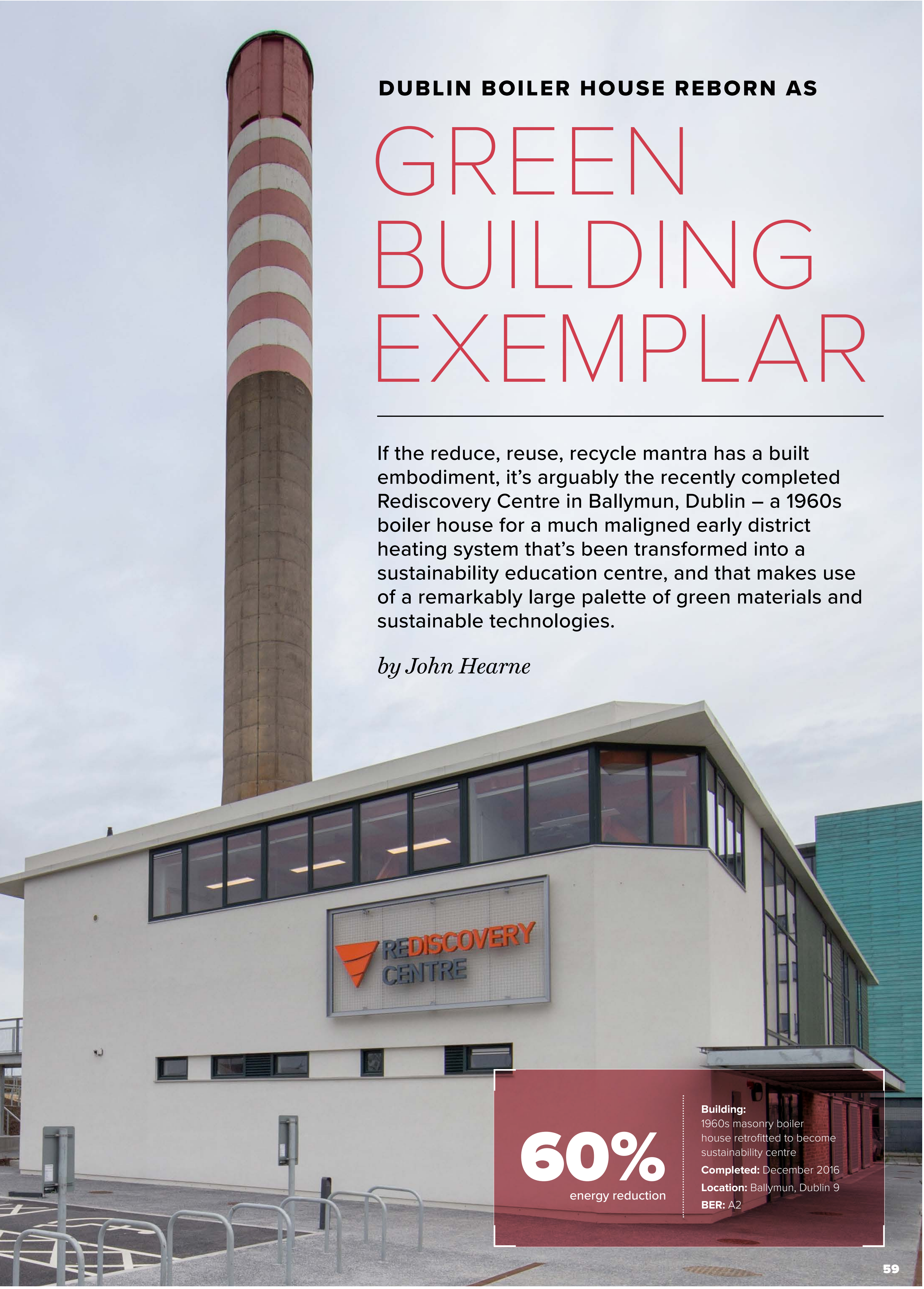


DUBLIN BOILER HOUSE REBORN AS

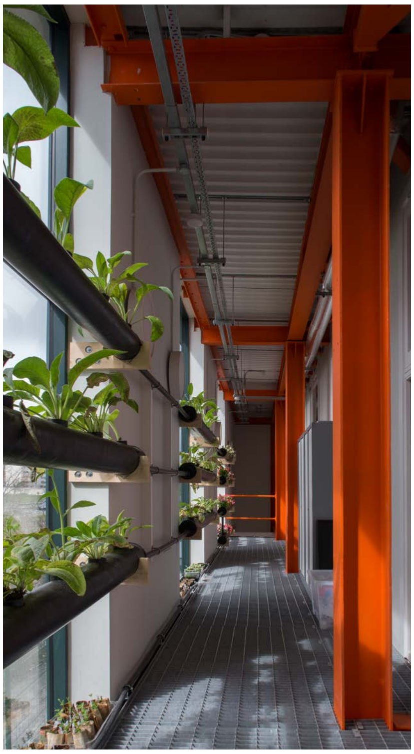
GREEN BUILDING EXEMPLAR

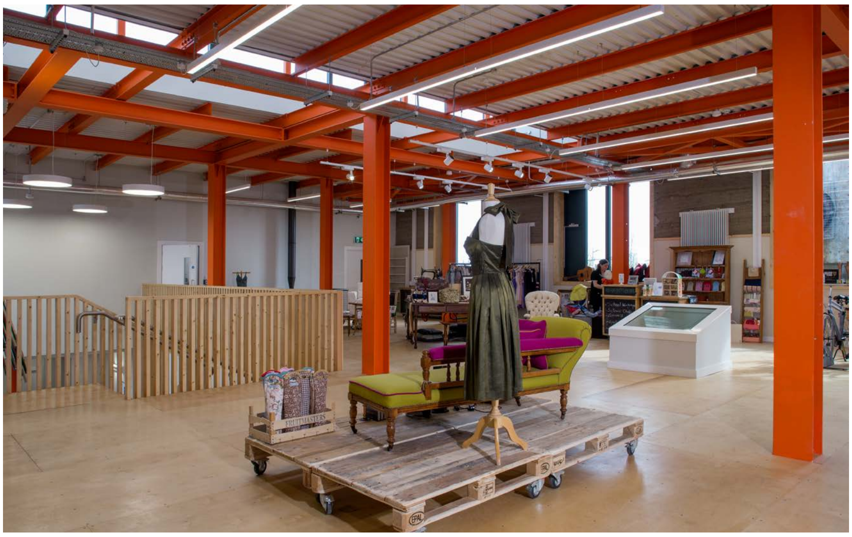
If the reduce, reuse, recycle mantra has a built embodiment, it's arguably the recently completed Rediscovery Centre in Ballymun, Dublin – a 1960s boiler house for a much maligned early district heating system that's been transformed into a sustainability education centre, and that makes use of a remarkably large palette of green materials and sustainable technologies.

by John Hearne

60%
energy reduction

Building: 1960s masonry boiler house retrofitted to become sustainability centre
Completed: December 2016
Location: Ballymun, Dublin 9
BER: A2





When the Ballymun Boiler House opened in the 1960s, it was by far the largest mass heating system in the country. It not only provided district heating to nearly 2,800 families, it also pumped fresh water directly to the newly built residential towers, obviating the need for local booster pumps.

Fifty years later however, with the flats demolished, the boiler house had fallen into disrepair and the site itself had become a dumping ground for construction waste. It was overgrown in places and contaminated by oil in others.

In 2013, Dublin City Council, Ballymun Regeneration and the Rediscovery Centre began a project to reinvent the site and create something unique in Ireland. The rejuvenated building would become an exhibition centre for sustainability and a home for the Rediscovery Centre – a grouping dedicated to providing community employment and training through a collective of innovative reuse enterprises. The design would exemplify sustainable refurbishment and showcase a wide range of green technologies and building methods.

Funding was secured from both the exchequer and the EU's Life and Environment Fund, and a lengthy design phase, led by ABK Architects, began in 2014. Main contractor Purcell - who draw from a vast experience in delivering high profile sustainable buildings, including a passive house school for the Department of Education in Moynalty, Co. Meath profilde in issue one of Passive House Plus - were appointed, and work started on site in January 2016. Ballymun Rediscovery-Centre opened a year later. The centre has been designed to ensure a minimum carbon footprint both in construction and throughout its life, while the structure features a very broad range of sustainable elements.

The layout sets out to make best use of existing features and to optimise solar gains, while accommodating an improbable range of technologies including an air-to-water heat pump, a stove fuelled by an onsite willow plantation, and a combined heat and power unit (CHP), as well as both solar thermal and photovoltaic panels – a variety that would look excessive were it not for the role of the building as a demonstration project. There's rainwater harvesting and green roofs, composting toilets, a liquid waste reed bed water treatment system as well as a long list of sustainable and reclaimed building materials.

Perhaps the most fascinating element of the build has been the way in which the design and build teams sought to minimise waste and create the new building out of the old.

Robert Davys of ABK Architects says that a core ambition of the project was to demonstrate the environmental value associated with building reuse rather than demolition.

"A key stage of the design process – and critical to the project's success – was the identification of original building fabric and contents suitable for reuse."

There are two headline elements here worth mentioning. The team found a way to retain both the original concrete slab and the main steel structure. Davys calculates that this action alone resulted in the avoidance of 55 tonnes of embodied carbon – and that's based purely on production impacts, without considering either disposal or transport.

This same ethos was maintained throughout the project. The original building included aluminium louvres which at one time helped to dissipate the excess heat generated by the Boiler House's three 35 tonne boilers.

"We saw aluminium louvres and thought that we could do something with them," says Davys, "so we came up with the idea of cutting them, rebending them, then using them to make aluminium shingles, which were then installed on the façade."

He explains that the process of choosing construction materials was based on an ordered prioritisation. First priority was given to materials salvaged from the boiler house itself. Next in line came building materials available locally from other building or demolition sites. Third were sustainable, natural, renewable materials or those made from recycled waste. If none of these streams provided what was required, materials with excellent thermal performance, low embodied carbon and environmental impact were chosen.

Making maximum use of the onsite materials required a great deal of flexibility on the part of the design and build teams. "It's a difficult thing when one has a desire to recycle and reuse, because you're never entirely sure of what you can reuse and recycle, even up to the detailed design stage."

For example: The roof deck of the old boiler

NORMALLY KEEPING THE HEAT IN AND THE WATER OUT ARE TWO PRIMARY CONCERNS IN A BUILDING AND YOU MIGHT USE FIVE MATERIALS TO ACHIEVE THIS, WHEREAS HERE, WE HAD CLOSER TO FIFTY.

house included a bituminous membrane mounted on softboard. This was not a material that the design team would have chosen to include, but at the same time, getting rid of it would have created a negative environmental impact. The decision was then taken to try to reuse it as a vapour barrier in the new build up.

"In principal, that sounded fine and quite a clever sidestep," says Davys, "but in reality, when you got down to the demolition and started pulling some of this stuff up, we found that it was full of holes, while the softboard underneath was saturated. To reuse it would have meant trapping a whole load of moisture in the building."

Often, a third way had to be found in order to retain materials that weren't quite up to the job they had originally been installed to do. Most of the decking used on the old boiler house was aluminium, and lacked sufficient resistance to retain the new fixings. Instead of ripping it up and throwing it out, OSB board was used together with expanding anchor rivets to strengthen it.

The project also features brick, timber, windows and even sheeps wool insulation salvaged from local demolition sites (though the notion that any buildings fitted with sheeps wool are being demolished warrants further investigation, given how comparatively recently the material has entered the supply chain.)

One of the Rediscovery Centre's reuse enterprises is Rediscover Paint. There, old, non-hazardous, water-based paints are collected from the public via recycling centres, then remixed and offered locally – and affordably – to residents and community organisations. This salvaged paint was used throughout the centre. Furniture and fittings that had been destined for landfill were also upcycled and reused. And of the three original 35 tonne boilers, one was retained as a 'symbolic vestige' of the original function of the building, while the other two were sent for recycling.

The design team had originally envisaged that recycled railway sleepers would be used to demark the kitchen garden. When these proved costly, the team took a fresh look at the site and ended up cutting up and re-using some of the boiler house's old steelwork.

This approach permeated all aspects of the design, not just the selection of materials. The building itself is a large, single volume, into which an additional floor was added during the construction phase. The site also features an adjacent, disused concrete reservoir.

"When we looked closely at the scheme we realised that the top of the buried reservoir on the site was more or less at the floor level we were adding into the building. Originally, there was a notion that we would clear the reservoir to make way for the kitchen garden, but instead, we decided to make a bridge from the new first floor level out to the top of the reservoir."

This provided an exhibition route that allows tour groups coming through the building to cross the bridge to the garden area, then descend the constructed slope at the other side.

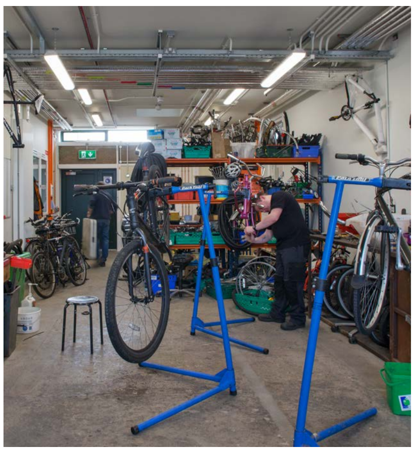
Part of the brief was to create a '3D Textbook' which would use the project as an educational tool, with the ultimate aim of inspiring behavioural change in everyone who passes through its doors. This motivation led to one of the central challenges of the build. If the designers had focused exclusively on creating a comfortable, healthy environment using sustainable materials, the palette of elements and technologies would have been kept tight and efficient. Instead, a range of complications were designed in.

"Normally," says Robert Davys, "keeping the heat in and the water out are two primary concerns in a building and you might use five materials to achieve this, whereas here, we had closer to fifty. With all of those different materials and different junctions, it was quite a head strain to make sure all the detailing was correct."

In order to tie the disparate elements together, certain common materials were deployed. First among these was hempcrete. Composed of hemp and lime, hempcrete provides structural strength, first and foremost, but it also acts as a vapour permeable insulator. It was used in the south and east facing walls of the centre.

By using hempcrete, the team avoided high embodied energy alternatives such as concrete blocks and cement, or indeed petrochemical insulants. Davys points out that despite the fact that hempcrete has been used in structures across Europe for the past ten years, the Rediscovery Centre is the first public building in Ireland to use this material.

Compared to virtually all of the buildings published in Passive House Plus, the U-values are relatively modest. In some ways the building is an inversion of the passive house approach – where the emphasis is on passive approaches to meeting heating needs, combined with mechanical ventilation to ensure good indoor air quality while recovering precious heat. In this building, it's fair to say there's more emphasis on sustainable mechanical technologies to heat and power the building, with passive approaches to delivering indoor air quality. It will be fascinating to see how an attempt at low energy building that's



Photography: Paul Tierney

SELECTED PROJECT DETAILS

Client: The Rediscovery Centre / Dublin City Council
Architect: ABK Architects
Consulting engineer: Homan & O'Brien Associates
Structural engineer: Punch Consulting Engineers
Quantity surveyor: AECOM
Main contractor: Purcell
Airtightness testing: Building Envelope Technologies
Windows and doors: Carlson & Company Ltd
Living wall: Sap Landscapes
Mechanical contractor: Dominic O'Connor Ltd
Electrical contractor: Doyle & Nugent Electrical Ltd T/A D&N Group
Carpentry, lime render & hempcrete: G, E & B Edwards Brothers Ltd
External render contractor: James Doran & Sons Ltd
Wood fibre insulation & render: Pavatex & Baumit, via Acara Concepts Ltd
Lime hemp binder: Brooks
Hemp shive build bale: KJ Voase and Son
EPS & phenolic insulation: Kingspan, via JP Corry
Mineral wool insulation: Knauf, via U Value Insulation
Thermally broken window vents: Renson
Solar thermal: Kingspan Environmental
Heat pump and micro CHP: Glenergy
Solar PV: Microstrain
BMS: Control Tech
External shading (awnings): Designer Shade Solutions
Carpentry: Apple Orchard
Painting & decorating: Grat-Ryan Painters & Decorators Ltd
Reed bed filtration system: Herr Ltd
Roof finish: ID Roofing
Engineered timber joists: Shannonside Building Supplies Ltd
OSB: SmartPly
Breather membrane & geotextile membrane, hydrophilic mastic ituthene & primer: SIG Trading (Ireland Ltd)
Metal purlins: Tegral Building Products Ltd
Paving brick, kerb, paving slab: Tobermore
Radon barrier, Malaysian plywood & timber cladding: Murdock Distribution Ireland Ltd
Tiling, tanking & matwell: Aston Crean T/A Crean Mosaics
Waterproofing / tanking: The Damp Store
Fitted furniture: Firacorn Joinery Solutions Ltd
Internal timber stairs: Mack Construction
Floor grinding, polishing & sealing: P Mac Ltd
Internal screens and doors: Accurate Joinery
Facing brick: Acheson & Glover / Kingscourt Country Manor Brick Co Ltd
Sanitaryware: Davies
Ironmongery: Proline Hardware
Stone & concrete blocks: Roadstone Ltd

so conceptually different from passive house performs over time.

M&E engineer Brian Homan of Homan O'Brien acknowledges that the broad suite of heating technologies were installed primarily for demonstration purposes, adding that all have been fitted with sensors and recording devices to keep a close watch on how they perform. As yet, the data collected hasn't been subject to detailed analysis to establish whether the building performs to its ambitious targets: Homan O'Brien used dynamic modelling and simulation to prove that 80% of the building's energy use would be generated on-site. (IES simulation software was also used to predict daylighting, natural ventilation and overheating levels).

One of the big challenges from Brian Homan's point of view centred on achieving the right balance of efficiency and thermal comfort from the variety of systems as the seasons pass.

"Now that we're into the summer, the PV panels are going to start coming into their own, and we might no longer need the CHP, while the solar thermal will be generating hot water – so at this time, it's getting the right balance between CHP and solar."

The building is ventilated passively, via windows at high level which can be triggered to open automatically. This system is supplemented by some mechanical ventilation in toilets and workshop areas – particularly the paint recycling centre which would have a requirement for additional air changes.

The heating technologies are co-ordinated by a BMS installed by Control Tech Ltd. Nigel Hayes of the company says that the system is calibrated to select the most efficient technology, or combination of technologies to run the building at any given time. It is aided in this task by an onsite weather station which measures temperature, relative humidity, barometric pressure, rain intensity, wind speed and wind direction. In addition, indoor sensors measure everything from temperature to CO_2 and total volatile organic compounds (TVOC) levels. All of these systems can be overridden for educational purposes, so that it is possible to select whichever technology is to be demonstrated. The system can also be used to co-ordinate the building's electricity use, balancing the CHP and the PV system to prompt the most efficient use of power.

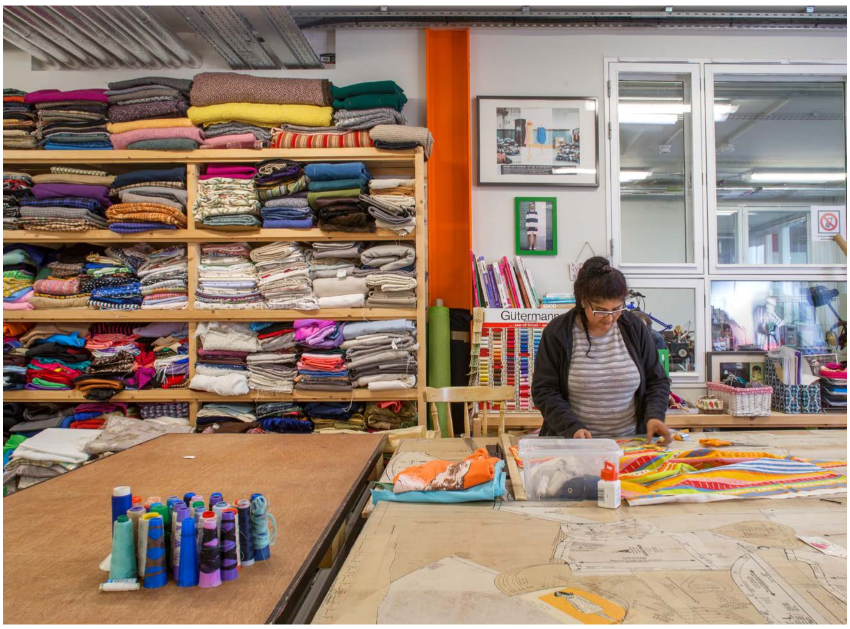
Control Tech also supplied a traffic light ventilation system – which may prove a critical way of protecting occupants from the risks of indoor air quality declining, given the potential for large variation in air change rates in naturally ventilated buildings. As long as air quality in the centre remains good, a green light is displayed. Once CO_2 or TVOCs move above pre-programmed set points however, that green light switches to amber, while red is displayed if another set of thresholds is breached. Users then react to these signals by adjusting ventilation levels to improve air quality.

A similar system operates for gas, electricity and water use. If these move above baseline set points, the traffic lights prompt a change in user behaviour.

Ballymun's Rediscovery Centre has been open now for a little over six months. Projections suggest that upwards of 10,000 visitors will pass through its doors before year end. As ABK's Robert Davys points out, the main aim of the centre is to effect positive behavioural change. "Every aspect of the building is being used as an educational opportunity."

Building services, construction materials and pipework have been left exposed and are labelled so that visitors know exactly what they're looking at. There are viewing panels into plant room, workshops and out onto the roof.

The project shows exactly what can be achieved from a site that three years ago was a rundown eyesore. It's fitting too that the site of the country's first ever district heating system has been repurposed to create an exemplar of sustainable construction.



HOW GREEN IS THIS BUILDING? BY JEFF COLLEY

There's clearly an awful lot to say about individual sustainability features of the Rediscovery Centre, and it's little surprise the judging panel at the 2017 Green Awards – who must have felt overwhelmed at the sheer level of detail – gave the centre not just the Green Building and Green NGO gongs, but also the overall Green Award.

But what is the net effect of such a rigorous attention to reducing material impacts? If truth be told, it's hard to say.

The building wasn't assessed using an environmental rating tool such as BREEAM or LEED, and it's arguable whether such an assessment would have truly cast light on the extent of the building's innovations in material use, reuse and recycling – neither tool attempts to quantify and publish the various environmental impacts of the choices made, be it in terms of anything from CO_2 emissions embodied in the manufacture of a given material, to the amounts of hazardous materials used.

This kind of detailed life cycle assessment – which would involve quantifying material impacts in the same way that energy calculation tools such as PHPP, national methodologies and dynamic simulation tools do to varying degrees of accuracy for energy performance – is still in its infancy, especially in terms of an approach that can be applied at scale.

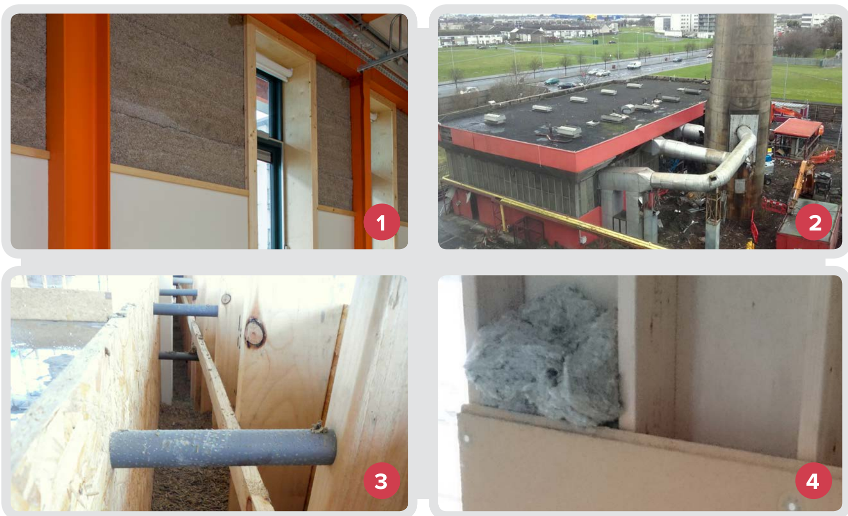
As Passive House Plus has previously reported, perhaps the best hope we have of really getting to grips with life cycle analysis is in combining the likes of environmental product declarations (EPDs) for materials – which can give us quantifiable data on individual materials – with new BIM tools (provided the information in those BIM tools accurately and in detail reflects the building's eventual construction, of course).

The ideal scenario would be if information from EPDs is automatically populated into BIM tools when a designer is inputting information on a proposed build spec, so that the effect of changing a material, an overall build-up, or even opting for a more compact building form could instantly be seen. And once enough buildings of a given type had been put through such a tool, benchmarks for average life cycle costs for each type would emerge – and with it the possibility of mandating quantifiable reductions under building regulations.

In the absence of such data – in particular for Irish buildings of any kind, let alone buildings of a similar type to the Rediscovery Centre – it's questionable whether a life cycle analysis would tell us much about this building's greenness. Frankly we have nothing equivalent to compare it against, at least in an Irish context.

That's not to say such an exercise would be futile, even if the task is made harder in the absence of the sorts of software innovations described above. On the contrary, we need to begin this process of quantifying the environmental impacts of our buildings – whether exemplary or run of the mill – as soon as possible. The environmental crises facing society are so vast, and the buildings we build or upgrade today will, with luck, be standing at the end of the century and beyond. We urgently need to know whether and to what extent those buildings are likely to help to reduce the built environment's impact on the natural environment, or whether they'll act as stark, physical symbols of this generation's failure to consider our effect on future generations – or even on the lives of people who have already been born.

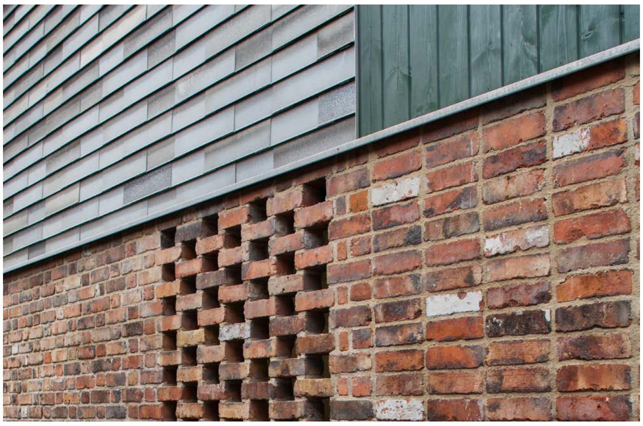
CONSTRUCTION IN PROGRESS



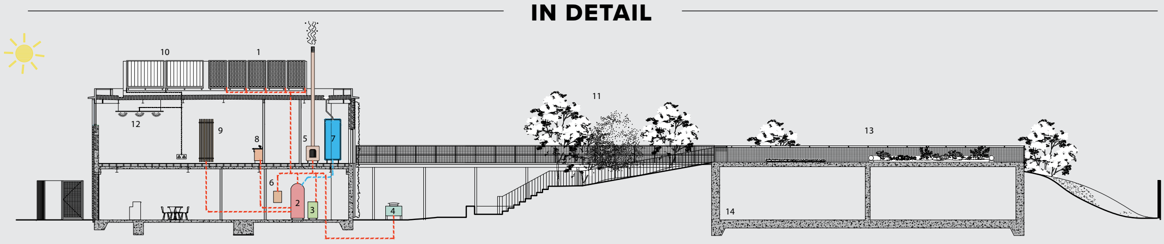
1 A panel of internal plasterboard intentionally removed to reveal the internal Hempcrete, a combination of hemp and lime that provides both insulation and structural function; **2** The derelict boiler house prior to the refurbishment; **3** Timber shuttering system for construction of the Hempcrete walls; **4** The timber frame wall sections were insulated with 150mm of reclaimed sheeps wool.

Water Management

The Rediscovery Centre's water management and drainage systems were designed to minimise waste water discharge, mains water use and sewage sludge generation. Conversely, the system maximises water recycling and nutrient recovery. In addition to rainwater harvesting from the building roof, the building features waterless urinals and composting toilets which make use of the onsite reed bed system. Urinal waste water is collected and used for plant nutrition in the internal comfrey wall. There is permeable paving and a vertical living wall, as well as green roofs. As with all of the systems in the centre, monitors are installed throughout, in order to keep track of usage and to ensure water quality.



IN DETAIL



Building type: Redevelopment of derelict district heating boiler house into new social & community resource centre, incorporating original original steel structure & concrete slab.

Location: Ballymun, Dublin

Completion date: December 2016

Budget: €2.5m

BER: A2 (90.84kWH/m²/yr)

Airtightness: 2.16/m²/hr at 50Pa

Ground floor: (At perimeters on east and west elevations only) 600mm concrete on DPM on 100mm of Kingspan Kooltherm to underside and face of concrete.
Overall floor U-value: 0.32 W/m²K.

Externally insulated walls: Existing concrete brick and open cavity wall overclad externally with 100mm Pavatex woodfibre insulation and Baumit mineral stucco finish.
U-value: 0.3 W/m²K.

Hempcrete walls: 300mm Hempcrete, followed outside by ventilated cavity and various external rainscreen claddings.
U-value: 0.18 W/m²K.

Timber frame walls: External timber rainscreen followed inside by timber-frame with 150mm reclaimed sheeps wool & 40mm Pavatex woodfibre insulation, plasterboard internally. U-value: 0.18 W/m²K.

Roof: 140mm high performance insulation with TPO membrane on OSB board on existing reinforced aluminium decking.
U-value: 0.16W/m²K.

Windows: Carlson Optiwood, with laminated timber painted window frames, double glazed 4-16-4mm, typically toughened outer pane, laminated inner pane, coloured bottom metal bead to match paint finish.
Average U value: 1.4 W/m2K.

Heating system: A 20 kW Neura L20EuC air-to-water heat pump – with a COP of 4.3 at air 2C / water 35C – as primary heat source when there's no demand for domestic hot water. Programmed to operate early in the morning to generate low temperature hot water for the heating system during "night rate" electricity hours. The hot water is then stored and can be used to heat the building during the day.

A gas-fired SenerTecDachs Micro combined heat and power (CHP) system is the primary heat source when there is a demand for domestic hot water and produces high grade heat as well as generating electricity.

Both systems are controlled from the building management system computer. The thermal output and the electric output of the CHP is monitored and the information stored so that it can be displayed and recorded for performance purposes.

A south-facing 15 sqm Kingspan Thermomax HP400 solar thermal array contributes to hot water supply. Other heat sources include a 1 kW Ecoboiler HE multi-fuel stove with back boiler to burn onsite willow, with a stated net efficiency of 71.5%, and a 30 kW Quinta Pro 30 gas fired wall hung condensing backup-boiler, with a SBEM rated seasonal efficiency of 97.6%.

The system has two heating circuits – one each for radiators on the ground and first floors.

Ventilation: The building is predominantly naturally ventilated. Mechanical ventilation is typically only used in WCs and the compost system ventilation exhaust. WCs have natural ventilator windows as well as mechanical extract. Thermally broken manually operated Renson TH 90 window vents.

Openable windows within the spaces. The system consists of a CO_2 sensing system with manual control in order to enhance the natural ventilation strategy and to improve the air quality within the individual spaces. This system allows the occupants to understand the need for clean fresh air and control of their own environment.

The woodworking workshop has a cyclone system that takes the dust out of the air and returns heat to the space.

Electricity: 16.4 sqm south-facing 2.5kWp solar photovoltaic array (10 x 250 kWp panels) with Goodwe inverter. Lighting controls include extensive occupancy detection and daylight detection, with LED lighting throughout.

Green materials: All materials selected with regard to reuse, recycling, sustainability and embodied energy. Material finishes selected for low levels of VOCs, petrochemicals and environmental toxins. Timber products are Irish where possible and FSC certified. Lime based internal plasters, recycled brick and upcycled louvres, reuse of concrete slab, steel structure, aluminium roof deck, masonry walls and concrete chimneys from original building, salvaged brick, sheeps wool reused from another DCC site, hempcrete walls, low VOC paints, Irish softwood, cardboard ducting for mechanical ventilation, no use of PVC, low VOC glues, formaldehyde-free MDF, staircase balustrade of Irish fir. ■

NORTH DUBLIN
SHELTERED SCHEME MAKES A1

BREAK THROUGH

€89 or zero

estimated annual heating costs excluding/including effect of PV array on heat pump running costs.

Development: Five-unit sheltered housing scheme (54 – 63 sqm)

Completed: February 2017

Location: Fairview, Dublin 3

Build method: Aerated concrete block with external insulation, foamed glass insulation to foundation

Standard: A1 BER

The first social housing scheme of any kind to top Ireland's BER scale, this project is a timely reminder that in the midst of a national housing emergency, it is possible to tackle climate change and blitz the forthcoming nearly zero energy building targets, while housing the most vulnerable in society in healthy, fuel poverty-proof homes predicted to incur zero heating cost.

by John Hearne

Extraordinary though it may be in energy performance terms, Linham Construction's housing scheme at Merville Avenue is on one level a built embodiment of recent Irish history: phase one of the scheme was completed in the death throes of the Celtic Tiger back in 2007, with phase two finally constructed last year. But in other regards the scheme is jarringly atypical. Although phase one was built at a time when standards on site were evidently at a historic low, numbers 1 to 10 Merville Avenue were a rare exception, a low energy sheltered housing scheme of externally insulated steel frame construction with a communal heating system, built with the support of SEAI's House of Tomorrow Programme – a grant scheme for house builders in a housing boom of historic proportions, if you could countenance such a thing. Phase two picks up where phase one left off. While over 99% of new homes built last year in Ireland achieved at least an A3 rating, fewer than a quarter of one percent – just 13 new homes – achieved an A1. Five of those were added by phase two on Merville Avenue, replacing one family home with five sheltered housing units, which further enhances the project's green credentials, by adding density on a brownfield site, without placing pressures on existing infrastructure.

The central challenge facing Linham MD Frank Flynn when he began work on the second phase of the Merville Avenue residential development in Fairview was actually getting at the site. A terrace enclosed on two

Photography: Tomasz Juszczazak, Image Works

sides by existing houses, the only access was at the rear of the property. Planning restrictions also added complexity: an original three-bedroom house on the site was demolished, but the front wall had to be retained for planning purposes.

Moreover, the ground quality was extremely poor. Conventional wisdom would have dictated the use of a lot of heavy machinery, a lot of concrete and a lot of steel. Instead, Flynn and technical designer Fergus Merriman decided that the key to the project lay in the use of lightweight materials.

The foundation is composed of 350mm Geocell foam glass gravel and aggregate — for which Linham is the Irish agent — under the concrete slab. Geocell is a lightweight, load bearing and highly insulating material that is also breathable and Pyrite-free. It boasts high compressive strength and is made from 100% recycled material. It's designed to remove the need for strip foundations and rising walls.

Chartered building surveyor Fergus Merriman says that in addition to providing hardcore, insulation and radon dispersal, the physical weight of the material makes it ideal for a project of this nature. A cubic meter of Geocell weighs just 140kg. The equivalent weight of concrete is closer to 2.2 tonnes. The ability to manoeuvre it around a small site without the need for heavy machinery is a significant advantage.

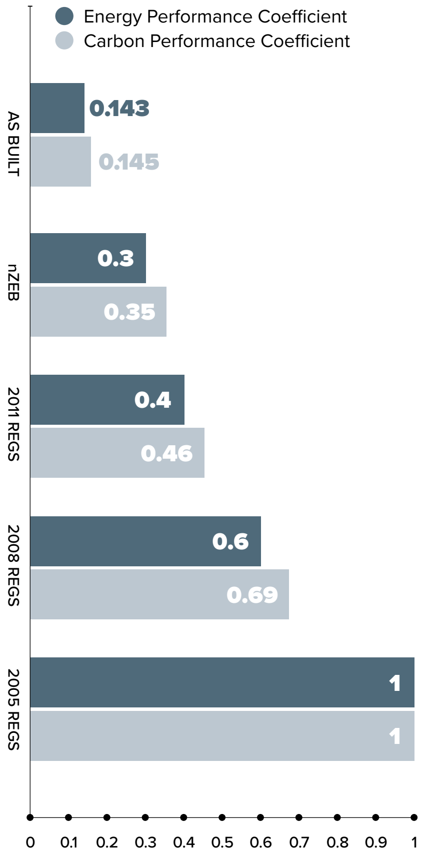
"In terms of green credentials," says Merriman, "we don't have to dig out as much, which means we don't need to take as much stuff away. Also, we don't impinge on neighbouring structures by driving pilings and making vibrations. You don't have to worry about neighbours because you're not digging under their walls."

The decision to go with lightweight materials was carried through to the wall build up. Merriman specified 215mm Quinn Lite thermal blocks with 200mm of EPS100 external insulation in the absence of an available light gauge steel frame system to match phase one.

As Frank Flynn points out, the physical weight of the material means you don't need a crane and you don't need a forklift. And like the Geocell aggregate, it does more than one job – delivering high thermal properties as well as structural strength.

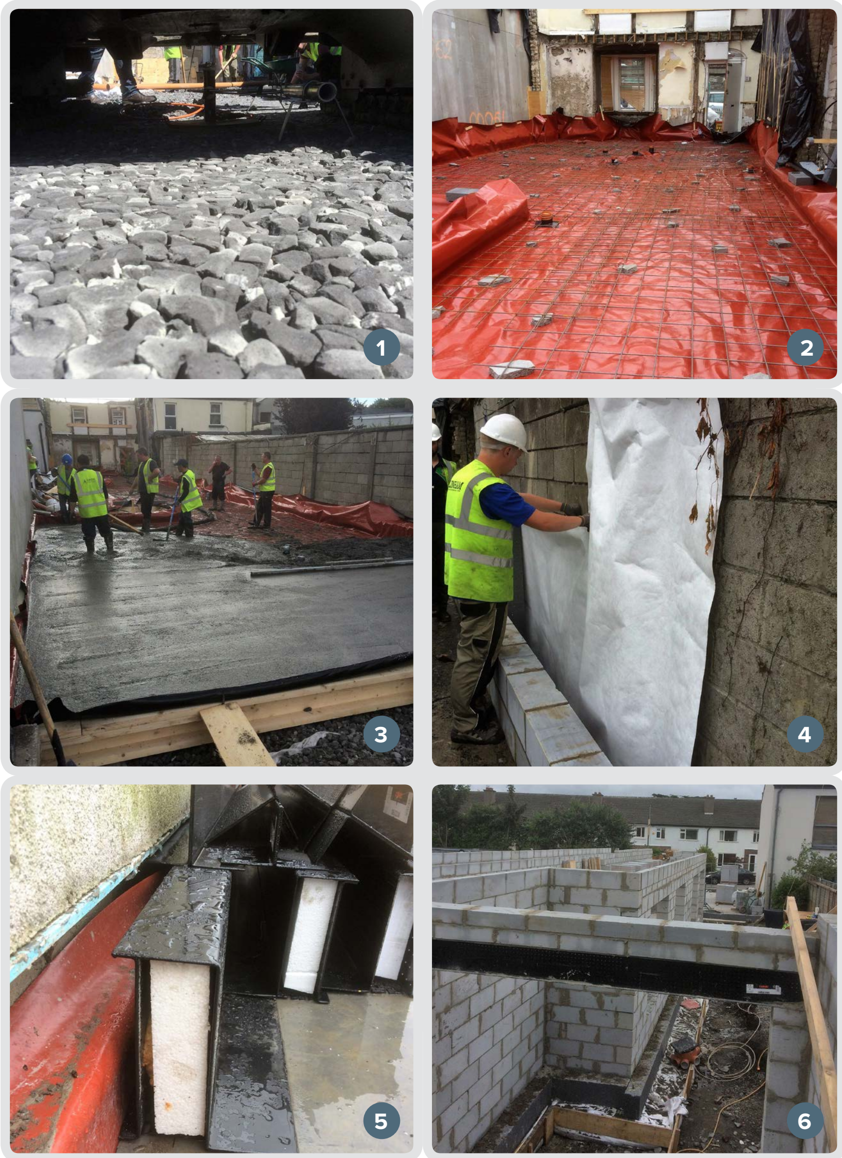
He also liked the fact that using blocks – and traditional block building skills – gave a measure of flexibility onsite. That's not to say Flynn is devoted to only building with onsite methods. "One size doesn't fit all," he says, "you adapt to your circumstances and your situation and there are good solutions in every case, but offsite is probably the future of the industry."

Airtightness comes primarily from an internal parge coat, complemented by a membrane in the roof and tapes at all of the critical junctions. According to Frank Flynn, one of the reasons airtightness and insulation specialists Cooper Insulation were selected was due to the firm's investment in a Wincon unit – a stripped down version of a blower



Linham managing director Frank Flynn at the Merville Avenue development.

CONSTRUCTION IN PROGRESS



1 The foundation is composed of 350mm Geocell foam glass gravel and aggregate under the concrete slab; followed by **2** a radon barrier; and **3** 225mm reinforced concrete with a power float finish; **4** Tyvek breather membrane behind insulation at boundary wall; **5** Catnic thermally broken lintels reduce the potential for heat loss from thermal bridging; **6** The 200mm Quinn Lite thermal blocks improve the overall U-value and reduce heat loss, and are rendered internally for airtightness.

door often described as a "spirit level" for airtightness. This meant Cooper Insulation could test for obvious leakage points as they worked, and thereby ensure the eventual obligatory airtightness tests wouldn't throw up any nasty surprises, thus avoiding the need for difficult and costly remedial work.

The windows are positioned within the insulation layer rather than the blockwork in order to prevent thermal bridges – although the Quinn Lite blocks permit substantially lower levels of heat loss than conventional blockwork, even thermal blocks are not a substitute for insulation.

The first phase was heated by a communal heating system consisting of two Alpha Therm condensing gas boilers and hot water cylinders, and the new phase taps into this resource for domestic hot water supply.

Meanwhile, Nilan Compact P units provide space heating, ventilation, and – if necessary – cooling, configured in this project to deliver heat via the ventilation ducts, rather than a conventional water-based heating distribution system of one kind or another. Flynn says that this is the first time he worked with this technology, and admits that he was a little bothered about whether or not it would work as planned.

"I didn't put in a boiler, I didn't put in rads – all heat is distributed through the ventilation system – I thought, what if it doesn't work? So I said I better have a backup plan, and that backup plan was additional electrical power points just in case they had to plug in more heaters."

As it turned out however, his fears have proven unfounded: so far, the residents who have moved in are all feeding back very positively about their new homes.

The five apartments – which had been presold to a housing association – have received A1 building energy ratings. Interestingly, Flynn says that achieving a spec of this quality adds in the order of 10% to build costs.

While focusing on higher performance building fabric did much of the heavy lifting needed to achieve the A1 ratings, reducing space heating loads can only go so far, as certain loads counted in Ireland's national methodology, Deap – lighting, pumps, fans and ventilation systems – require electricity to run, and the electricity figures included in BERs take account of the huge energy losses incurred in power generation and transmission. Onsite renewable electricity generation therefore takes on particular significance, albeit for a significantly lower energy demand in this case.

Flynn opted for arrays totalling 28 PV panels with 300W output each, configured to give as much energy as possible to the apartments, while stopping short of battery storage. The resultant banks of arrays, which came with separate inverters for each apartment, are helping to meet base loads provided by the likes of refrigerators, heat recovery ventilation and appliances on standby, while contributing to seasonal heating loads and, if needed, active cooling from the Nilan system.

Calculated output in Deap – which PV suppliers Alternative Energy claim understates the PV contribution by some 20% compared to the PV*Sol tool they use – put that contribution on average at 1411W per apartment per year. According to Eoin McGann of energy consultants 2eva.ie, Deap's new heat pump calculation tool – which is particularly punitive to exhaust air heat pumps, which use much warmer indoor air as their source temperature compared to air source heat pumps – calculates the annual space heating provided by the heat pump at 635.4 kWh. "This could cover the heating bill twice over," he says. "50% of each PV system should cover the entire seasonal load of all the apartments with 50% left over to be used for part of the base load."

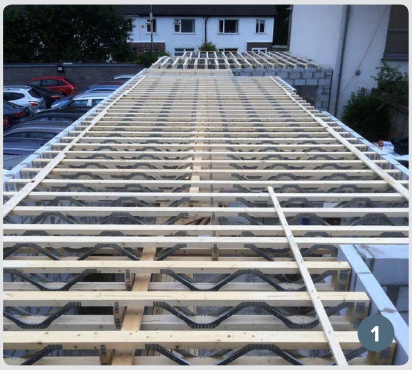
Not all of the apartments are yet occupied, and it's too soon to draw conclusions about actual energy use. But resident Roseanna Murphy loves her new apartment.

"Talk about a hell of a big difference? I lived in a private flat for eight years and it was very damp. This is my little dream home. I haven't got one complaint about it. I've got central heating and air conditioning. My breathing got a little bit better since I moved in...I couldn't have asked for better."

SELECTED PROJECT DETAILS

Client / project management: Linham Construction
Planning consultants: Patrick Harrington Architects
Assigned certifier / technical designer, fire safety and disabled access certifier: Merriman Solutions
Civil / structural engineer: Benchmark Property
Mechanical contractor: Eurotech / Nilan
Electrical contractor: Geoghegan Electrical
Wall insulation: Xtratherm, via Gerard Kellys
External insulation contractor: CKF Interiors
External insulation render system: MBC Project
Roofing contractor: Aplus
Roof insulation: Dow / Knauf
Insulated foundations: Geocell
Metal web joists: Wolf Easi-Joists, via Doherty Timber Frame
Thermally broken lintels: Catnic, via Tradecraft
Airtightness products: Ecological Building Systems
Airtightness & insulation contractor: Cooper Insulation
Windows and doors: Wright Windows
Roof windows: Keylite
Plasterboard & parge coat: Gyproc
Heating / ventilation system: Nilan
Photovoltaic supplier: Alternative Energy
Sanitaryware: Gerard Kellys
Slates: Tegral
EPDM membrane, breather membrane & wetroom flooring: Resitrix / Tyvek / Tarkett via Laydex
Wetroom flooring contractor: MJA
Insurance: Homebond
Finance: Bank of Ireland

CONSTRUCTION IN PROGRESS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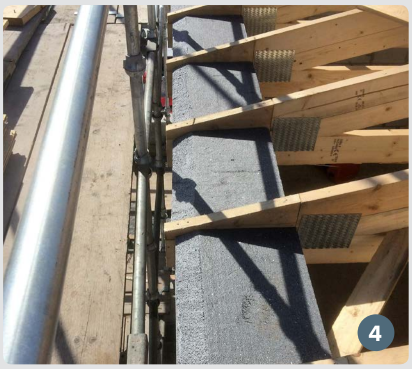
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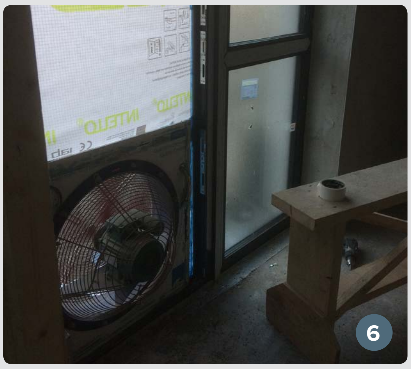
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1 Wolf Easi-Joists in the roof for organised installation of services; **2** Windows bracketed externally onto blocks to reduce cold bridging; **3** The walls are externally insulated with 200mm Xtratherm platinum EPS 100 insulation; **4** EPS brought up into eaves to meet roof insulation; **5** Airtight parge coat to walls, with Intello membrane to ceiling and battening for the Gypframe ceiling to contain services inside the airtight layer; **6** Cooper Insulation's Wincon unit, which enabled the Linham team to test for obvious air leakage points as they worked.


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IN DETAIL

Development type: Externally insulated masonry apartment building consisting of five units – ranging from 58 to 64.5 sqm each.

Location:
11-15 Merville Avenue, Fairview, Dublin 3

Completion date: February 2017

Budget: €390,000

Passive house certification: N/A

Energy performance coefficient (EPC): 0.1094 (average)

Carbon performance coefficient (CPC): 0.1024 (average)

BER: A1 (17.74 to 22.52 kWh/m²/yr)

Estimated heating costs: €89/year or zero, calculated based on Deap and assuming an electricity price of €0.14 per kWh. The cost differs based on excluding / including effect of PV array on heat pump running costs, and ignore any additional contribution the PV arrays may make to reduce electricity costs for non thermal loads.The figures are based on temperature assumptions in Deap (Given an average living area fraction for the five apartments of 39.07%, these estimates assume each apartment is heated to 19.17C for eight hours per day during the heating season.)

Airtightness: 0.93 – 2.18 m³/m²/hr at 50 Pa

Thermal bridging: Single leaf Quinn Lite AAC block construction wrapped in external insulation, with Catnic thermally broken lintels, windows sat in insulation layer, Geocell foamed glass foundation system and detail extending external insulation beyond wall plate level to meet roof insulation. Y-value: default value of 0.08.

Ground floor: 350mm Geocell foamed glass insulation on ground, laid and wrapped on Terram 700 geotextile, radon barrier, 225mm reinforced concrete with a power float finish. Tarkett vinyl flooring system in wetrooms consisting of Aquarelle waterproof cove skirting for the wall, and Primo Safe-T flooring. U-value: 0.16 W/m²K

Walls: Kabe acrylic render system, followed inside by 200mm Xtratherm platinum EPS 100 insulation, 200mm Quinn Lite blocks (rendered internally for airtightness with taping at junction), battens & Gyproc plasterboard. Rockliner sound insulation used on compartment walls between apartments. U-value: 0.11 W/m²K

Slate roof: Tegral Thrutone slates externally, on 32 x 38mm treated battens, on Tyvek 'Supra' breather sarking, on 150 x 50 treated cut timber roof at 400mm c/cs, with 400mm Metac insulation laid between webs of and on top of Wolf Easi-Joists at ceiling level, with Intello membrane.
U-value: 0.13 – 0.15 W/m²K

PVC roof: Alcor PVC roof in sheet form on tongue and grooved OSB on trusses, ventilated at eaves and in roof space. 400mm Metac mineral wool insulation between rafters over Intello airtightness membrane with sealed joints and edges, on battens, on Gypframe ceiling system with 12.5mm plasterboard & skimmed finish.

Flat roof: 50mm pea gravel finish on Geotextile membrane, on Resitrix EPDM single ply membrane, on 75mm Dow Roofmate insulation, on 22mm WBP plywood, on 200 x 50 metal web joists at 400 centres, with 200mm mineral wool fitted between metal web over Intello with sealed joints, on 12.5mm plasterboard and hardwall skim coat.

Windows: Triple glazed argon-filled PVC windows with low-E coating and an overall U-value of 1.12 W/m²K

Roof windows: Two Keylite double glazed windows, one in each stairwell – outside of thermal envelope of apartments.

Heating, ventilation and cooling: Passive House Institute certified Nilan Compact P units in each apartment, including exhaust air heat pump with integrated cooling and heat recovery ventilation system – a closed loop system which utilises extract air at room temperature.

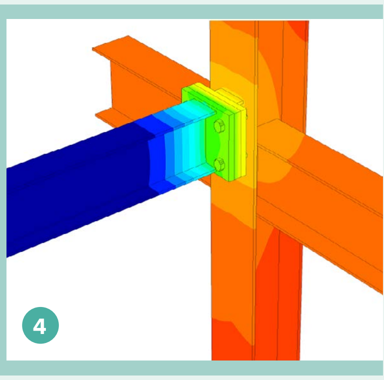
Electricity: 28 panel 8.4kWp PV system, including separate inverters for each apartment.

Green materials: Geocell recycled foamed glass aggregate.

■

The PH+ guide to: THERMAL BREAKS

Building physics take no prisoners. Anyone designing, constructing or upgrading the thermal envelope of a building to modern energy performance levels is duty bound to understand and minimise thermal bridging, or suffer the consequences. One-man thermal bridging encyclopaedia Andrew Lundberg of Passivate, who teaches thermal bridging analysis at Dublin Institute of Technology, gives some practical advice on why and how to tackle thermal bridging head on, and describes some of the leading innovations in thermally broken components.



When it comes to low energy building design, the heat is truly on. In fact, we should really stop talking about low energy building design as if it's something that will happen in the future, and take on board the fact that we are in the final phases now of implementing the nearly zero energy building (nZEB) standard across Europe, including the UK. Low energy building is basically the new bog standard. In this quagmire of trying to design to reduce heat losses, maintain low U-values despite the need for structural elements, fire resistance, acoustic performance etc., as well as the need to avoid mould growth and condensation, what is the magic bullet?

Well, in short, there are many products which try to play the roles of many in one, commonly referred to as thermal breaks. In some cases, manufacturers of these products have done extensive testing and design already for you, in order to prove their products in multiple common installations, which makes it much easier to specify. In other cases, the need for thermal breaks is brought about from a small number of bespoke junctions which arise due to some aspect of the design which necessitates penetrating the thermal envelope with a structural or aesthetic component.

In these cases, the design and specification of the thermal break takes place by thermal analysis of the junction to determine its additional heat loss and temperature profile. The thermal analysis results can tell you a lot – and on large-scale projects the inclusion or exclusion of a thermal break can result in many tens of thousands of Euros / Pounds spent or saved – so knowing what to put in and where to put it is crucial.

In the words of Miles Kington – repeated famously by Ireland and England's favourite ex-rugby player: "Knowledge is knowing a tomato is a fruit. Wisdom is not putting it in a fruit salad". Materials used to make thermal breaks can consist of anything from high-density EPS (expanded polystyrene), aerated or lightweight concrete, foamed PVC, cellular glass to polyamide / nylon, basalt or rubber, to name but a few.

To identify where a thermal bridge occurs, and hence identify which product is best used to reduce its effects, a designer should be able to take a pencil on a full set of construction drawings in plan and section, and run around the primary insulation layer of the entire building without having to lift the pencil to jump across a non-insulating or structural component. Where the pencil needs to be lifted, put on the brakes, zoom in and focus.

In the following section we'll look at some typical locations for thermal bridges and some products which can be used to improve them.

Linear thermal bridges

When it comes to thermal breaks at linear thermal bridges, we're talking here more about locations where two building elements meet, be that two or even three or more external building elements, or where internal elements meet external elements such as internal partitions or intermediate floors - and not where linear thermal bridges in planar building elements, such as timber studs in timber framed walls or joists in ceilings – occur. Some of the most common linear thermal bridges occur at junctions in masonry construction, particularly at ground floor connections where the entire leaf, or just the inner leaf, is continuous down to foundation, thus bridging the cavity / external insulation connection to the floor slab insulation. The most common solution to this is the use of a low-density or aerated concrete block lieu of a standard medium density block at the junction.

One important question regarding thermal breaks is where they are best placed. In the case of a standard wall / floor junction, and indeed most junctions, such a block is placed as closely as possible to the ideal line of where the insulation would have continued if it weren't for the structure that bridges it. In masonry construction, this is normally for two courses below internal floor level. Naturally, the more courses are laid the lower the rate of return for each additional block course in terms of internal surface temperature achieved and additional heat losses (accounted for by linear psi-values). The same rule applies anywhere that a concrete structural leaf breaks the line of insulation, such as at gable wall junctions with roofs insulated at the ceiling line, or inner leafs of parapet walls, where only a thin layer of insulation follows the upstand of the wall above the roof line. Simply put, where structure replaces insulation, that structural component should have the lowest thermal conductivity possible while still satisfying all other requirements of it from a building regulations compliance, cost and practicality perspective.

Several concrete block manufacturers are now promoting blocks designed to reduce thermal bridging, all manufactured in standard concrete block sizes. This means there is practically no re-training or upskilling required by trades who have to install them. These products can be worked on site just like a standard concrete block. These kinds of considerations need to be borne in mind when specifying materials for thermal breaks. The thermal conductivity values for aerated concrete blocks typically ranges from 0.12W/mK to 0.33W/mK. To give this some context, the thermal conductivity of softwood timbers is typically 0.13W/mK, and hardwoods up to 0.20W/mK. Compressive strengths of these blocks are normally anywhere from 3N/mm² to 7.5N/mm².

Other thermal breaks which can be used at linear junctions in masonry, pre-cast or in-situ cast concrete structures include Foamglas, a cellular glass product. It has a thermal conductivity of 0.055W/mK. In terms of relative performance, a poorly performing glass wool insulation roll product will typically be at 0.044W/mK, so as thermal breaks go this is quite good. This product however must have absolutely even load spread from the next course above it, ruling out for example the use of hollow block directly above it, and it cannot be tapped or struck with any tool, so care on site is of crucial importance. The compressive strength of these blocks at breaking point is 2.9N/mm², and with a safety factor used, a load bearing capacity of 1N/mm² should be used in structural calculations.

6

Another product range which has been developed primarily to improve thermal bridges around windows and door installations, while of course not being limited to these locations, is the Compacfoam range of products, distributed in Ireland by Partel Ltd. in Galway. These products demonstrate very good thermal conductivity values (typically 0.038W/mK and 0.046W/mK), a range of available high compressive strengths, high resistance to deformation under load, as well as low water absorption properties. This means that they are both very frost resistant and also maintain their thermal properties despite moisture conditions around them. They are also relatively breathable, being close in molecular structure to an EPS product. They are available as pre-milled profiles or blocks / slabs which can be cut on site. Speaking from personal experience, these products provide a very elegant and simple solution to door threshold details, however if buying in slab form I would encourage all users to contact the suppliers for information regarding best practice on-site cutting of the product!

5

The use of cantilevered concrete balconies is still widespread in apartment construction. As the cantilevers are commonly a direct continuation of the internal floor slab, where insulation is being installed internally, in a cavity or externally, the insulation line is inevitably broken by the concrete slab. For such situations, Schöck have a wide range of products in the Isokorb range which deal with the most typical requirements (e.g. fully cantilevered balconies, balconies with uplift forces as well as gravity, balconies supported by concrete columns). In principle they all consist of an expanded polystyrene core into which structural rebar is embedded. These components can transfer bending moment stress and shear forces as well as uplift forces. The equivalent thermal conductivity of these components will depend on the steel content and specific polystyrene used, as across the vast range steel sizes and spacings as well as overall product size will change depending on the requirements of the project or location of installation in the envelope.

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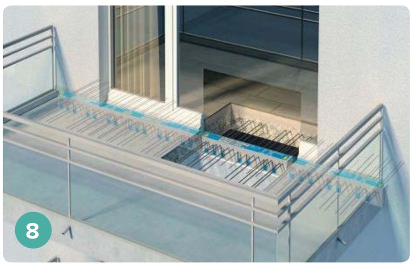


8

The vastly expanding range of thermal breaks includes **1** Keystone Hi-therm lintels; **2** Celcon AAC blocks; **3** TeploTie basalt wall ties; **4** Farrat structural thermal break plates; **5** Compacfoam high density insulation blocks; **6** Foamglas Perinsul cellular glass blocks; **7** the Quinn Lite range of AAC blocks and **8** Schöck's Isokorb insulated balcony connectors.

Mould growth and the fRsi factor

Typically, the risk of surface condensation and mould growth increases with internal humidity loads in buildings and / or reduced quality of the thermal envelope. The requirements for reducing risk of mould growth in buildings are outlined in Part L and reference other documents such as information paper IP1/06 published by the BRE in 2006. In this document, the calculation of the surface temperature factor, or fRsi, is presented. The fRsi value is calculated by dividing the lowest identified internal surface temperature (Ti) by the overall temperature difference across the structure (dT or delta T for temperature difference) under standard conditions. Those conditions in Ireland and the UK are 20C inside and 0C outside. So therefore the higher the fRsi value, the higher the internal surface temperature under those conditions, and the less likely mould growth occurrence is on that surface or point.

For dwellings, the critical fRsi value which must be achieved is 0.75. This means the lowest temperature allowable on any surface in a building is 15C, based on an overall dT of 20C or 20K. Based on a standard internal condition or 20C and 60% RH, 15C is the temperature at which 80% RH will be present on a surface. These are the conditions under which mould may begin to grow and become visible after a short period of just a few days. For buildings with lower expected internal RH levels, such as warehouses, the critical level is therefore much lower at just 0.3 fRsi. And for buildings with higher moisture loads, such as swimming pools (both in dwellings or commercial), the critical fRsi is 0.9. This means the lowest internal temperature allowable is 18C under standard conditions. This is readily achievable across planar elements. Achieving this at all junctions in a building is a much more onerous task, hence the need to take this requirement on board at a very early stage of design development. There is obviously a difference between factors which drive mould growth in occupied buildings and those which are tested under the fRsi method for demonstrating compliance with building regulations. Regardless of the intended room air conditions in an occupied building, the test method outlined in IP1/06 must be followed in order to demonstrate compliance of the design.

Point thermal bridges

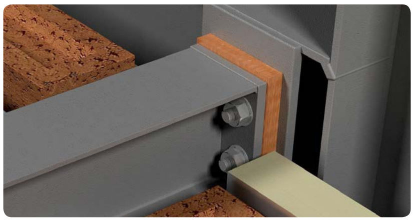
Point thermal bridges occur anywhere that the thermal envelope is penetrated by a structural element, and these can be roughly divided into two categories. The first are very localised penetrations, such as where a steel column penetrates a ground floor slab down to foundation, to support a structure such as an opening into a kitchen extension, in two or three locations. The second type must be taken far more seriously, as these are repeating point thermal bridges which form part of a wall or flat roof build-up, and therefore can have a very significant effect on the elemental U-value. In the case of the first penetration through the floor, the additional heat loss from these penetrations must also be included in the U-value, however as their occurrence is very low, their overall effects on U-values is normally quite insignificant as their additional heat loss is spread out over a much larger area. As long as the penetration doesn't cause any risk of condensation, be it surface or interstitial, that's basically ok, albeit not ideal.

In the second example however, normally one might have helping-hand brackets in a rainscreen cladding system, wall ties in a cavity wall, or upstands in a standing-seam flat roof system, which means the occurrence of the penetration occurs for example at 600mm vertical and 900mm horizontal centres. So the area of the element over which the additional heat loss is accounted is much less than in the previous example, and therefore the effect is much more significant. For example, where three penetrations to a floor slab occur at single points, and the floor slab itself measures say 96 sqm, the additional heat loss from these three point penetrations is spread over this area. Whereas, in the case of the helping-hand bracket mentioned, there is a single penetration by a bracket for every 0.54 sqm of the wall, and so the effect is significantly greater. This too can be ok, as long as one knows about it from the offset at specification stage, and can work around the realistic U-value in ensuring that overall compliance is achieved. What is happening in reality is that designers and builders are being caught unawares, with 3D numerically modelled U-values showing U-values significantly higher than assumed at the design stage and the project already on site. The consequences of this typically affect time, quality and cost, as solutions are sought to bring a project back into the compliance sphere following its quick departure into the stratosphere of failure. So what do these penetrations look like, and how do we best deal with in order to avoid serious issues?

The image below shows a steel column (abutted by the inner leaf of a cavity wall on both sides) penetrating through a floor slab down to a foundation pad. Ignoring other numerous obvious issues with this image, let's focus on the continuity of the steel down to foundation.

Image showing non-thermally broken, continuous steel to foundation.

In this case, splitting the steel into two columns and inserting a thermal break, would serve many purposes. Manufacturers such as Armadillo and Farrat have designed thermal breaks for this scenario.



An illustration of an Armadillo thermal break plate.

As shown on the image, the thermal break itself is quite thin, with thicknesses from 13mm to 50mm available for this product. The compressive strength of the break pad is 290N/mm^2, and it has a thermal conductivity of 0.30W/mK.

The location of the thermal break in the construction is also very important, and this would need to be determined firstly in order to correctly design the steels. Firstly, the thermal break would always be installed in the same line as the insulation of the floor (or other element). But at for example 25mm thickness, with perhaps 150mm thick insulation in the floor, where then does one place it? The reality is that this would need to determined by thermal modelling, so anyone interested in specifying this should firstly approach the supplier for guidance and perhaps project-specific modelling of the detail, or at pre-specification the services of an NSAI-accredited thermal modeller, or a UK competent assessor (as outlined in Part L supplementary guidance documents) should be engaged.

Other considerations must also be borne in mind in locating the break, such as ensuring

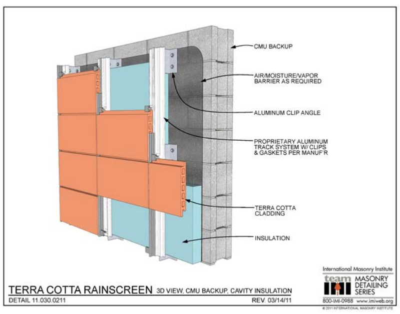
continuity of DPM / radon barriers in the floor slab without creating tricky unbuildable solutions, and thereby designing in a performance gap in the project.

Other advantages of breaking the steels include the fact that the shorter sections can be installed quite easily during construction of the rising walls and the structural slab poured without having to support the entire portal frame on site. The remainder of the frame can then be installed just before installation of the insulation, with access to the bolts still being available at this stage, and with a much neater repair to the DPM. The screed can then be poured around the steels.

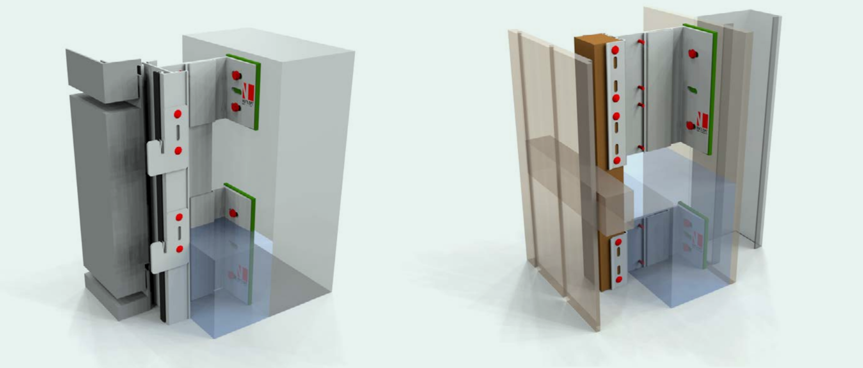
These thermal breaks do little as regular insulators, but at specific points like the ones discussed here, they pack a serious punch over small areas. Not only will they reduce heat losses through steels, but they can also quite dramatically improve internal surface temperatures, thus reducing risk of mould growth and condensation. Unfortunately, mould growth is still occurring at far too significant a rate in new build construction, when of course there should be none whatsoever. And the harsh reality is that in many cases it has inadvertently been designed-in.

The next type of thermal bridge which demands our attention is the penetration of primary insulation layers in roofs and walls by repeating thermal bridges such as helping-hand brackets, shelf angle brackets, standing seam roof clips and so on. These systems are being increasingly used by architects and designers as the variety of finishes, colours and textures available provide a comprehensive palette that rendered block or brick simply can't match.

The terracotta rainscreen image shows a typical example of such a system.



In this example, there is only one layer of insulation on the wall. In all such cases, the helping-hand bracket fully penetrates the entire insulation layer. Now we must consider the fact that the thermal conductivity of the insulation typically used in these systems is about 0.020W/mK, and the thermal conductivity of an aluminium helping-hand bracket is circa 160W/mK. That's an 8,000-fold increase in thermal conductivity per area. Take a wall area of 600 sqm with brackets installed at a rate of 2.5/sqm, and you have 1,500 brackets. Now we start to get a feel for how significant the additional heat loss can be when such a system is even used on one wall section of a reasonably sized apartment block. This is where the importance of correctly specifying and installing a thermal break to the back plate of the helping hand bracket becomes crucially important.



Nvelope bracket & rail systems - one with high risk (left) of thermal bridging and the other (right) with the potential for better performance if the stud is insulated.

The systems in these images from Nvelope shows the same bracket and rail system installed here on a cast concrete structure and infill metal stud walling system. In the first image, the bracket penetrates the only insulation there, and will therefore have the more detrimental effect. In the second image, it would be common for insulation to be installed between the metal studs. In this case, the helping-hand bracket doesn't penetrate the entire thermal envelope, but only the outer insulation layer. So typically, in like-for-like comparison, the additional heat losses due to the bracket in the first image will be greater than in the second. This is despite the bracket, rails and thermal break being identical.

So the key point here is that the same system installed in different wall build-ups will perform completely differently. Normally, the suppliers of rainscreen systems are not the suppliers of the wall system, and someone else is supplying the insulation and perhaps someone else the thermal break. So when you as a designer are presented with a table of additional heat loss, or chi-values, or dU (additional penalty values to be added to a U-value) values for a bracket or thermal break, treat these with extreme caution, if not completely ignore them. The odds on that value actually being applicable to your specific wall build-up are as likely as the next White House communications director lasting more than 10 days in the job.

In most examples of such systems that I have calculated, it's common for a wall U-value to increase somewhere between 30-50% with the inclusion of the rainscreen cladding system. In many cases for example, walls with U-values of say 0.14W/m²K for planar elements will ultimately end up with a U-value of 0.21W/m2K. This is not an issue when identified at design stage, and the value of 0.21W/m²K is used in the DEAP/SAP/SBEM calculation for the building. Where a 'default' and actually inapplicable value for the rainscreen has been used, with a resultant U-value calculation of say 0.17W/m²K being entered into the compliance calculation (or worse yet no addition for the rainscreen system at all), on projects which are already teetering on the edge of demonstrating compliance, let's just say that the presentation at the next design team meeting never goes down well. This is all course completely avoidable.

Concluding comments

There are a few lessons that we still need to learn. Thermal bridge free construction in reality doesn't exist. Thermal bridges arise mainly from one of two sources, the first being the way we insulate across junctions and around penetrations of the thermal envelope, and the second being literally the way we measure buildings internally in Ireland and the UK. Rather than trying to kid ourselves into thinking we can eliminate thermal bridges, we should set the lower target of trying to treat them as best we can, in the most cost-effective and practical manner, so that what we design can actually be installed without either hanging facades from proverbial sky-hooks or requiring a degree in origami.

A cross-disciplinary approach is required to the specification of thermal breaks. We must comply with building regulations, and in this case the key ones (but not limited to) that come to mind would be structure, fire, acoustics and energy. This would mean a thermal modeller communicating with a structural engineer, fire consultant, acoustic consultant and system supplier, ensuring all parties are satisfied, all coordinated by the architect or project manager to achieve the required result –and all of this happening before the turn of the sod. A bizarre and new concept I know – forgive my sarcasm – but it's one which might save many an embarrassing project meeting, result in fewer delays on site, reduced costs of remediation during construction, and improve the quality of buildings produced for the end user, which is the least they deserve. ■

Next issue...

The PH+ guide to:

Heat recovery ventilation

The next issue will include our guide to heat recovery ventilation, explaining why this technology is effectively mandatory for passive houses in all but the warmest of climates, and what to watch out for to ensure your system performs in terms of in door air quality, energy use, comfort and acoustics.

Grenfell Tower

How did it happen?

Investigations may eventually confirm the specifics of how the fire at the West London tower block spread so catastrophically on the night of 14 June, but the government and construction industry faces much deeper questions about whether a culture of deregulation, cost-cutting and buck-passing turned what should have been a small, inconsequential fire into a national tragedy.

by Kate de Selincourt

The Grenfell Tower tragedy has horrified everyone. The stories – stories of people trapped and dying in full view of their neighbours — are unbearable to hear. But the construction industry has to hear them. It has to be haunted by them. Because a building has failed, catastrophically, and 80 people are dead.

In the weeks that have passed since that awful night, a police investigation has been launched, as has a public inquiry under retired judge Sir Martin Moore-Bick. The government has also appointed an expert panel under Sir Ken Knight to give immediate advice, and has announced a formal review of the building regulations under Dame Judith Hackitt.

But the immediate and specific reason for the terrifying intensity of the blaze seems to have been the use of a combustible cladding system in the refurbishment of the building, which was carried out just a year ago. Watching video footage of cladding flaring up and pouring off in flames, it is hard to come to any other conclusion.

Inside the building, a series of additional factors potentially made things even more dangerous for the residents. It's possible that internal fire breaks and compartmentation were compromised during the refurbishment, perhaps after the new heating system was installed.

Surprisingly to many, the tower retained its gas supply, including individual supplies to each flat. Risers and pipes in landings and stairways were supposed to be clad in "fire-rated" boxing, but contractor Cadent Gas has reportedly said that "work was still ongoing to box in the lateral pipes" when the fire occurred. The London Fire Brigade was reported as saying that it had been unable to

Photo: Wasi Daniju

put out the fire – which started when a refrigerator caught fire in a fourth floor flat – until fire fighters had isolated a ruptured gas main.

Smoke protection or extraction systems in the stairwell appear to have either been unable to deal with the quantity of smoke, or to have failed. Certainly, a number of the injuries and fatalities were caused by smoke inhalation when occupants were attempting to get down the stairs.

These issues relate not only to the refurbishment – its design and execution – but also to the ongoing management of the block. At the time of writing, the Royal Borough of Kensington and Chelsea, and the Kensington and Chelsea Tenant Management Organisation are both being investigated for possible corporate manslaughter.

But the initial focus has been on the cladding system. Important questions remain about the integrity of the firestopping, and whether the nature of the assembly created a chimney effect that accelerated the blaze. But we now know, after tests carried out for the government by the BRE, that the system used at Grenfell Tower has failed the tests set out in Approved Document B of the building regulations. It is flammable. It should never have been installed on the building.

The outer rainscreen cladding at Grenfell Tower was a Reynobond PE composite panel made of an unmodified polyethylene core sandwiched between two layers of aluminium. This was set about 50mm away from the insulation that was fixed against the rough concrete walls of the 40-year-old structure. For the most part the insulation was Celotex RS5000, but the vertical columns and corners were insulated with Kingspan Kooltherm K15 – and Kingspan has stated that this use of the product was "as part of a combination for which it was not designed and which Kingspan would never recommend." Both these synthetic foam insulants are combustible at high temperatures. In the test at the BRE – which tested foil-backed PIR insulation with stone wool fire barriers behind a polyethylene-filled aluminium composite material (ACM) rainscreen cladding – it took just nine minutes for the flames to reach several metres up from the top of the six metre high mock-up cladding system – just nine minutes to establish the cladding system should not have been on that building. How, then, did it come to be there?

> Just weeks before the Grenfell disaster, the insurance industry warned the government of the dangers of flammable cladding on buildings.

While the deeper, cultural answers to this question are difficult to pinpoint with accuracy, the reasons appear to be wrapped up in the culture of deregulation and cost-cutting that has gripped both the construction industry and government over the past decade.

Particularly since the Conservatives came to power in 2010, but stretching well back into the Blair years, successive governments have prioritised deregulation as part of a "war on red tape".

In January 2012, the then prime minister David Cameron said he intended to take "concrete steps to make it easier for businesses to cope with the great big machine of health and safety that's built up... the health and safety monster." It was one of many similar statements he and his government made.

This culture of deregulation also extended into construction. When a housing standards review was announced in 2012, the government's guiding principles included its desire for a "proportionate" role for regulation, which "mustn't stifle growth or innovation". And fire safety was not spared the deregulatory credo, despite repeated pleas and warnings that the fire safety regime was a danger to human life.

According to the BBC, after a fire at the Lakanal House tower block in south London killed six people in 2009, the all-party parliamentary fire safety and rescue group petitioned government ministers to reform Part B of the building regulations, which deals with fire, by including provision for automatic sprinklers and revisiting fire standards for cladding.

Despite this advice, rules to mandate sprinklers were not introduced, apparently as they might have discouraged house building. While former housing minister Brandon Lewis accepted that automatic sprinklers save lives, he stated that it was not the government's responsibility to make them mandatory. "It is for the fire industry, rather than the government, to market fire sprinkler systems effectively and to encourage their wider installation," he said, citing the government "one-in, two-out rule" on new regulations.

Civil servants echoed the deregulation dogma of the time. According to the New York Times, Brian Martin, the top civil servant in charge of drafting building-safety guidelines, said at a conference in 2011: "If you think more fire protection would be good for UK business, then you should be making the case to the business community, not the government." He reportedly quoted the then fire minister, Bob Neill, as saying: "Should we be looking to regulate further? 'No' would be my answer."

The New York Times also reported that, two years later, when the coroner questioned Brian Martin about the Lakanal House fire in London, he defended the building regulations. When it was put to him that the public would be horrified to learn that the rules allow the use of combustible panelling, Martin reportedly said: "I can't predict what the public would think, but that is the situation." He also said that demanding the use of non-combustible cladding materials "limits your choice of materials quite significantly".

A visceral dislike of regulation seemed to grip members of government. Retired architect Sam Webb, who sits on the all-party fire and rescue group, recalls: "I sat in one meeting where we discussed the need for the retro-fitting of sprinklers during the refurbishment of multi-storey blocks of flats."

"As [former chief fire officer] Ronnie King patiently outlined the reasons, the then minister for DCLG [Department of Communities & Local Government] pointed his finger and shouted, 'Mr King you are in a minority of one'. When we interjected, the minister leapt to his feet, threw his papers down and stormed out of the room, shouting as he went that he was resigning from the group."

Sadly, there had been no shortage of hard evidence about the danger of combustible cladding systems. In Shanghai in 2010, a 28-storey apartment building, which was under renovation, was consumed by fire. Fifty-eight people were killed and 70 were hospitalised. It is believed that the fire spread via polyurethane insulation on the external walls.

A series of dreadful fires in the United Arab Emirates also caused tremendous damage and a number of injuries, though mercifully no loss of life: measures such as sprinkler systems, effective compartmentation and safe escape routes are believed to have saved lives. As a result of the UAE fires, combustible cladding materials were banned in the country and new regulations covering construction practice and quality control are in the process of being introduced.

There have been similar fires closer to home. A fire in a tower block in Irvine, North Ayrshire killed one person and injured five more in 1999. The fire spread up the outside of the building via combustible cladding. Ten years later, the fire at Lakanal House also spread via external cladding.

The Fire Sector Federation has had a long-running campaign for a review of Approved Document B to the building regulations, and recently produced a brochure titled 'Why does Approved Document B need to be reviewed?' Approved Document B provides technical guidance on how to meet Part B.

Tom Roche, chair of the FSF's built environment workstream, warned: "Increasingly, ▶

as a Federation we are noting combustible combinations in terms of construction systems and insulation products within building assemblies. This is evident in the scale of fires that we are witnessing, in the UK and abroad."

"As a federation our concern has been that these changes are outrunning the current testing regimes in the UK, that the testing of individual components and not systems gives a misleading picture of their true fire performance."

The website Safety and Health Practioner reports that at the FIREX International convention, coincidentally held just a few days after the Grenfell disaster, Dennis Davis of the Fire Safety Federation said his industry had warned about the building regulations "time and time and time again".

"We are desperately worried, in particular the approved documents falling behind what is going on within the built environment," he told delegates. "We must get over this. 2006 [sic] is the last review. Ten years is too long a gap, far too long a gap if you consider how much construction and building has changed."

This brings us to the desperate situation at Grenfell Tower on the night of 14 June. The building's external cladding system, which lit up like a match, may even turn out to have been compliant with Part B — or at least, legalistically speaking, compliant with one of the four different ways that building control bodies have suggested the regulation can be interpreted.

Why don't we know for sure? Because Part B -and the manner in which it is interpreted by building control bodies — is dangerously confusing.

In relation to external fire spread, Part B itself simply states: "the external walls of the building shall adequately resist the spread of fire over the walls and from one building to another, having regard to the height, use and position of the building." (It makes an almost identical statement for roofing).

The word 'adequately' is discussed in some detail, but what it means in essence is that the building should be very hard to set on fire from the outside.

The official technical guidance (Approved Document B) offers two ways to meet the regulation. Wall components should either meet the guidance defining limited combustibility set out in the document, or meet the performance criteria in BR135, a technical standard for the fire performance of external insulation in tall buildings, which subjects full scale replica wall assemblies to a standardised fire test.

However in 2014, the Building Control Alliance (BCA) published additional guidance on the use of combustible cladding materials for buildings over 18 metres high. It said: "If no actual fire test data exists for a particular system, the client may instead submit a desktop study report from a suitable independent UKAS accredited testing body (BRE, Chiltern Fire or Warrington Fire) stating whether, in their opinion, BR135 criteria would be met with the proposed system."

This meant that, rather than submitting a cladding system to a full fire test to BR135, you could essentially ask an expert to give their professional judgement on whether it would meet the standard if tested.

This 'desktop' approach rapidly took off, and became the basis of approval after approval in the three short years after it was introduced — even though it appears the BCA viewed this as a method of compliance that would only be used in limited circumstances.

As Kingspan put it in their own guidance on "routes to compliance" published in 2016, the desktop study report has become: "a commonly adopted method of demonstrating compliance with an increasing number of private and local authority Building Control Bodies (BCBs), as well as structural warranty and insurance providers."

After Grenfell, these warnings were reiterated by the BCA, which said that in the case of using options three and four to comply with Part B, any conclusions about the fire safety of an external cladding system resulting from studies must be "supported by hard test data and based on fact and not purely opinion". The BCA added that testing used to justify the conclusions of desktop reports should be "specified and carried out by UKAS accredited testing stations".

But we know that despite this BCA advice, opinion kept creeping in. Evans noted in the same presentation that "reports from some fire engineers [are] still being based on opinion not fact."

At the start of July, BBC Newsnight reported that it had seen two desktop reports by testing firm Exova Warringtonfire, which used the argument that a fire test would produce a similar result if either composite aluminium cladding or non-combustible ceramic tiles were installed outside of a combustible insulation material. Was this fact or opinion?

> A cultural shift is needed. Buck-passing needs to become a sign of weakness and failure, accountability a mark of strength and success.

In 2015 the BCA issued further guidance offering a fourth method of compliance, though this now appears to have been withdrawn, and the original 2014 advice restored in its place. However, we have an idea what the 2015 guidance contained, because that same year the National House Building Council (NHBC) published a 'technical extra' on a variety of topics, including a discussion of the BCA's then new fire guidance.

The NHBC report refers to this fourth option as follows: "If none of the above options are suitable, the builder may consider a holistic fire engineered approach for the entire building." The NHBC added that volume two of Approved Document B recognises this as an acceptable alternative approach to fire safety.

This essentially provided a route whereby the performance of the building as a whole, including all fire safety measures, could be considered within a standardised framework (there is a relevant British Standard) to determine whether or not it offers an acceptable level of fire safety.

In a presentation published on the website of the Council for Aluminium Building, Steve Evans of the BCA said that desktop reports should be "based on reasoned arguments/facts not opinion" and should "justify any discrepancies between the tested and proposed build ups." His presentation added that desktop reports should avoid "leaps of faith". He warned that applying data from dissimilar materials could lead to inaccurate conclusions.

The reports argued that it was acceptable to use successful fire tests involving ceramic tiles as a guide to the likely fire safety of a cladding system using aluminium panels. The aluminium panels in the two desktop studies contained fire retardants, unlike those at Grenfell Tower. Nonetheless, experts Newsnight spoke to expressed concern that the arguments advanced by the authors were not sufficiently evidence-based. These assessments, one expert told the BBC, "appeared to extrapolate an apple into an orange".

Why did the desktop approach to certification gain such dominance, despite the fact that — relying as it did on extrapolations from actual tests — it was inherently less certain? Indeed, why was it offered in the first place?

It is not even clear that the BCA was the driver of the 'alternative routes' approach. There is a suggestion that, rather, the guidance was an attempt to catch up with a runaway construction industry.

According to a 2016 Rockwool-sponsored continuing professional development (CPD) module in Building magazine, the BCA guidance was published "following the completion of a number of construction projects not compliant with Approved Document B or the guidance contained in BR135."

But why not simply clamp down on non-compliant projects? Was there pressure

DO MODERN CONSTRUCTION CONTRACTS CREATE POORER QUALITY BUILDINGS?

On a refurbishment project like Grenfell Tower, the procurement and installation of materials, the continuity of design intent into the final build, the checks that compartmentation has been reinstated and fire-resistant protection put over gas pipes after retrofit – all of this comes down to the designer and the contractor.

Except at Grenfell there wasn't a single designer and a single contractor. The Metropolitan police have reportedly identified 60 companies that played some role in the building's refurbishment.

Studio E Architects were involved with the initial design, and appear to have been retained by the Royal Borough of Kensington and Chelsea, the client. Rydon was the lead contractor, but reportedly subcontracted the design of the facades to Harley Facades. As is common with a contract of this size, numerous sub- and sub-sub contractors were involved. Some went into administration during the project.

Speaking at an event organised as part of the London Festival of Architecture shortly after the fire, Matthew Needham-Laing – an architect, but also a lawyer who negotiates construction contracts — described complex contract structures starkly. "There is no single point of responsibility. Responsibility is collective, meaning there is arguably none," he said.

Meanwhile architect Jeremy Till, former head of the architecture schools at both Sheffield and Westminster universities, told Passive House Plus: "I think there is a huge problem with the corrupted procurement process that pushes the risk down and down the chain. And along with the risk, goes the responsibility. The market effectively atomises responsibility, with no one authority having an overview."

Passive house designer Alan Clarke explains how hard it can be to pin anything down with these complex structures: "I have sat down with a contractor to solve some snags on a build, but found out that the services at issue had been installed by three separate sub-contractors, none of who had turned up to the meeting."

Design-and-build contracts hand the initial design over to the contractor, who may modify aspects in order to control details and in theory, make it easier for them to stick to the contract price. However this structure can remove influence from designers, making it harder for them to take responsibility.

"When you are novated to the contractor, it is difficult to alert the project client. You can't easily say things are being done wrong by the contractor – because that's your client. You have no authority," an architect with experience of design and build contracts told Passive House Plus.

The Grenfell disaster has led to calls to "bring back the clerk of works" and "re-empower architects". It is probably far too early to fix on one solution. But it is hard to see any single additional role making much impact, unless the entire chain buys in. A cultural shift is needed. Buck-passing needs to become a sign of weakness and failure, accountability a mark of strength and success.

Minutes from an emergency Grenfell Tower residents' meeting held during the refurbishment in 2015 show that residents expressed concern about the quality of renovation work. The minutes detail numerous problems, including "concern that TMO [Kensington and Chelsea Tenant Management Organisation, the body that manages all of the borough's council housing] / Rydon are using cheap materials and 'cutting corners' on workmanship".

Cost-cutting can of course be demanded by the client, and this seems to have happened at Grenfell (see main article). But cost-cutting also seems to be built in to the business model of many contractors. First, they tender low to win the work, then they try to claw more profit margin out of the price by pruning costs wherever possible. Fixed price contracts are often demanded by lenders who feel this 'de-risks' the investment for them.

One veteran of passive house builds commented: "I've been told by quantity surveyors that prices are often estimated on the basis of previous jobs, which will have been won by the lowest tenders – not all of which will have covered the actual cost of the work."

This can lead to a scramble to cut costs, claim for extras, and deliberately pass blame on to someone else. It doesn't make for a collaborative, constructive atmosphere.

A passive house architect with experience on a design-and-build project recalled what happened when a contractor's anticipated cost-cutting met the more exacting spec of a passive house build.

"The contractor was upset that they could not change the spec — they could not substitute cheaper components, which is where they expect to make their margins. They couldn't change the windows, they couldn't change the membranes, they couldn't change the MVHR. I think they were really frustrated and stressed. They possibly under-tendered because they had not quite twigged they would not be able to change these things – it's not the way they are used to operating."

The architect added that on many jobs, the client won't even realise these substitutions and omissions are happening.

Some suspect that public sector contacts may be particularly vulnerable to this effect. Procurement consultant Colin Cram wrote in the Guardian that spotting such practices depends on the team managing the contract having sufficient expertise to recognise when it happens.

"The traditional model of construction procurement by local authorities and housing associations in England is no longer viable...Few councils can afford the expertise required for [running the contracts for] major building and refurbishment projects," he wrote.

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not to "stifle innovation"? As a recent article in the Financial Times explained, so-called "functional regulation" – which sets out the goal of the regulation, rather than prescribing in law exactly how to achieve it — aims to leave room for flexibility and innovation in meeting the law.

One fire engineer was quoted in the paper as saying that with very prescriptive, conservative regulations, "fantastic buildings like the Shard…probably couldn't be built."

Given the sheer number of potential cladding build-ups that are possible, if the regulations were to insist on full testing for every system with combustible elements, far fewer combinations would be permissible. Design options would become more restricted, buildings might become more expensive to build, and some products would lose market share (while others would gain it). Thus the desktop option took off.

Was the cladding on Grenfell Tower compliant with the regulations? The Department of Communities and Local Government, who publish the regulations, maintains that it was not. It clearly wasn't compliant with the wording of the regulation itself – the surface spread of fire was not adequately resisted. The components were not "of limited combustibility". We now know that had the build-up been directly tested before it was specified, it would have failed. In other words, it failed to comply with either specific compliance route set out in Approved Document B.

Nonetheless, could the cladding build-up have been compliant with some of the recently-issued and more nebulous guidance, and thus acceptable to a building control officer?

In a statement released shortly after the fire, DCLG revealed the government was not itself certain at that stage – saying it was "possible" that there might be some whole-assembly tests using panels like those at Grenfell that complied, though it was not aware of any.

"We are also aware that some ACM ▶

[aluminium composite material] panels are accredited as having a 'Class 0' rating for the surface. But that, in the Department's view, supported by expert advice, is a rating for the surface only and does not cover the limited combustibility requirement for the core or filler material within an ACM panel."

We don't yet know how this particular build-up was approved. But we do now know that an insulation and cladding build-up intended to replicate the one at Grenfell Tower failed fire testing by the BRE.

As Passive House Plus was going to press, the BRE was carrying out similar tests on five more cladding configurations, but results were not yet available. In practice, of course, many more than six possible combinations of materials are used as part of cladding systems.

For now, the government has advised the owners of 82 buildings known to have wall cladding that consists of aluminium composite panels with polyethylene filler in category three (the highest combustibility rating) and foam insulation that this combination does not meet current building regulations. These building owners are advised to undertake an immediate fire safety audit, put in place a plan to review the cladding system, and undertake remedial work — in particular to remove cladding. The expense and the anxiety of occupants in the meantime is immense.

The question now lingers: how did we get here? Did designers and specifiers become immersed in a culture where the industry regarded compliance with Part B as a paper challenge, rather than a matter of physics, and a matter of life and death?

An article written by a cladding manufacturer for the website Building Construction Design, published in January, discusses the challenge of keeping costs down while meeting both thermal performance and fire safety requirements.

"The risks of non-compliance can be high," the article says, "firstly of prosecution under Building Control legislation, also litigation under health and safety legislation, such as the Corporate Manslaughter Act. This could potentially lead to fines and imprisonment." This kind of language is very common in industry literature. The risk of injuring or killing people is rarely mentioned.

Writing in Building Magazine, Mark Farmer, who reviewed the issue of construction labour for the UK government, warned that: "Confusion over cladding testing is already perpetuating the feeling that some of our most important industry standards are indeterminate, lack transparency and appear open to gamification or playing the system."

The Fire Protection Association was blunter, saying that the way Part B was being applied "encourages value engineering to support a race to the bottom".

So against a government background of deregulation and austerity, and driven by confusion over building regulations, the construction industry appears to have become more preoccupied with 'tick-box' compliance than with actually preventing fires.

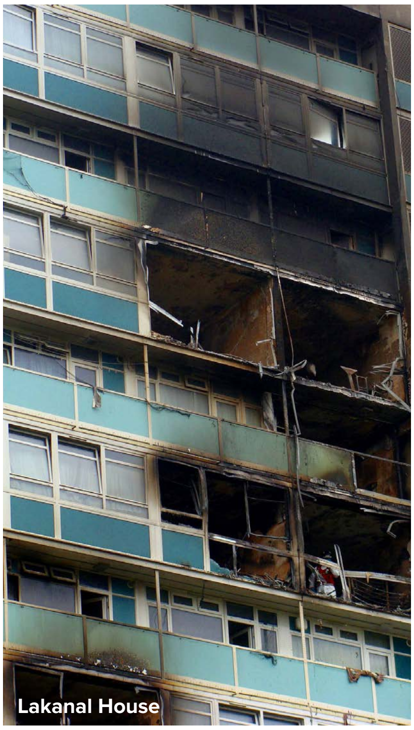


Photo: Peter Gasston

At the same time, the nature of modern construction contracting (see sidebar) now means responsibility is often passed down through chains of sub-contractors, with an emphasis on cost-cutting at each step of the way.

According to a report in the Guardian, in 2012 the original contractor for the Grenfell Tower refurbishment, Leadbitter, said the project would cost £11.3m. Planning drawings at this stage show that the architects and engineers had proposed cladding with a fire-retardant core, the paper reports.

The overall cost of the project was rejected as too expensive and the council appointed Rydon instead on a tighter budget of £8.7m. According to the Guardian, Kensington and Chelsea Borough Council's housing and property scrutiny committee was told that Rydon had "submitted the most economically advantageous tender, scoring highest on both price and quality".

The Guardian and BBC both report seeing financial documents confirming that almost £300,000 was cut from the cost of the cladding system used on Grenfell Tower by changing from zinc panels with a fire retardant core to cheaper aluminium panels – apparently described internally as a "value engineering process". It is not clear from the information shared by the BBC what grade of ACM panel was being considered at this point.

According to the Guardian, cuts were also made to the way the gas risers fitted inside the tower's internal corridors were treated. "About £60,000 worth of intended works to duct panels and ventilation grills for the risers were omitted, according to the documents," the newspaper says.

And just weeks before the Grenfell disaster, the insurance industry warned the government of the dangers of flammable cladding on buildings.

"The Association of British Insurers told ministers in May that outdated building regulations should be reviewed because they had failed to keep pace with modern construction methods, including the installation of flammable surfaces," the Financial Times reported.

Experts warned repeatedly about the risks of catastrophic fires in buildings with external cladding panels. "Nightmare scenarios include multiple-fatality building-engulfing fires," warned a report from the firm Probyn Miers, experts in construction dispute resolution, who had studied the fires in the UAE.

Labour MP and former firefighter Jim Fitzpatrick, secretary of the all-party parliamentary group on fire safety and rescue, said successive ministers had "sat on" plans to review building regulations ever since the Lakanal House fire.

And while fire deaths have fallen by 30% in the last decade, between 2015 and 2016 this trend reversed by 15%, with a 5% increase in the number of fires attended. That was before Grenfell Tower.

Over the past decade, as construction boomed on the back of soaring prices and soaring rents, "innovative" buildings sprang up everywhere. And now a horrifying new prospect, that the shackles of regulation will be thrown off even further, rears its ugly head as Britain prepares to leave the EU.

Grenfell may be the worst, but it is far from the only construction scandal where the suspicion lingers that prioritising price over quality has wrecked lives. This is why Grenfell haunts me, and should haunt us all.

Just before filing this article, I visited Grenfell Tower. It is an ugly, disfigured mess: the track of the inferno, the upwards fade to black where the flames grew hotter and hotter still as they rose; the broken, twisted fixings standing starkly away from the structure, a skeleton tracing out the ghost of its deadly load. On a breezy weekday in late July, I visited Grenfell Tower, and there in the street I wept.

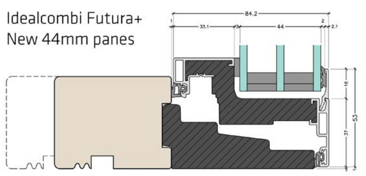
There, huge and devastated, is the physical presence, the physical consequence, of a thousand decisions made to get things done a bit more cheaply, to make a bit more money, to clinch that deal. To do things that plenty of other people in the industry do, so therefore they must be ok. To see a building as a drawing, a programme, a calculation, a challenge, a victory, an expense, a labyrinth to navigate, a set of hurdles to overcome — but never as a home.

The police, the Crown Prosecution Service, and ultimately the courts will judge which, if any laws were broken. But beyond any doubt, this is a crime scene. Eighty people dead and many of them are still up there. Grenfell Tower is a mass grave. It hangs over west London, brutally reminding us all that our priorities have been very, very wrong. ■

Marketplace

Keep up with the latest developments from some of the leading companies in sustainable building, including new product innovations, project updates, events and more.

New Idealcombi Futura+ achieves even lower U-values



Low energy window manufacturer Idealcombi has updated its Futura+ window to achieve even greater thermal performance, lowering the average U-value from 0.87 to 0.74 W/m²K. "For six years, the innovative Futura+ has been setting the standard for minimalistic contemporary window systems with great thermal efficiency," a statement from the company read.

"Idealcombi Futura+ was launched in 2010, being the first composite window system incorporating PUR (polyurethane) as a thermal break in the construction. Not alone was the Futura+ the first window system using PUR, but also the only window system with inward and outward opening functions with the exact same 53mm external profile."

Last September, Futura+ picked up the award for best window at the 2016 Build It Awards. Futura+ has been installed in projects of all types, from renovations and extensions to custom new builds, passive house, and public and commercial schemes. The recent performance update allows the change from 38 to 44mm window panes, improving the thermal efficiency of the triple glazed pane, with U-values as low as 0.59 W/m²K on large elements using krypton gas.

The updated Futura+ continues to be Secured by Design certified, meeting standard PAS24:2016.

For more information see **www.idealcombi.com.** ■

(above) Idealcombi's Futura+ windows now offer impressively low average U-values of just 0.74 W/m²K.

Ecological launches technical guide to Gutex roof products

Ecological Building Systems has published a new Gutex 'Thermal Roof Solutions' technical guidance document. Gutex, based in the Black Forest, is a leading German manufacturer of wood fibre insulation with over 80 years of experience. While Gutex wood fibre boards also have applications for floors and walls, the roof application has become particularly popular in recent years.

Gutex wood fibre boards have featured in many passive and low energy projects, both new build and retrofit, many of which have featured in Passive House Plus. But with over 14 boards in the Gutex range, selecting an appropriate product for each area of the building fabric can be challenging for specifiers.

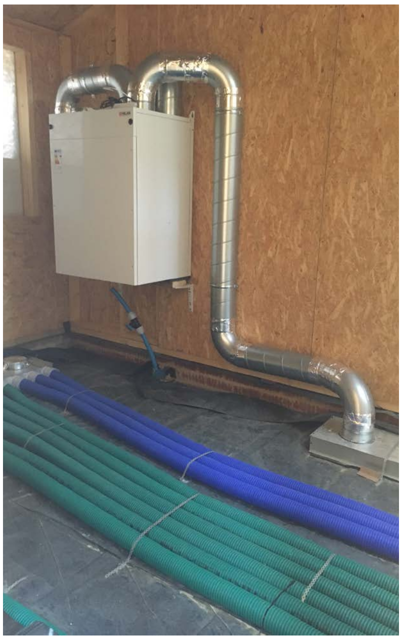
It is with this in mind that Ecological have launched their new Gutex 'Thermal Roof Solutions' technical guidance booklet for high performance, weatherproof and breathable roofs. The new guidance booklet provides technical details regarding Gutex Ultratherm and Multiplex Top, including critical in-depth roof details.

"When thermal insulation is specified, normally the priority tends to be to insulate against heat loss in winter months," said Ecological Building Systems' technical engineer Niall Crosson. "But if there is a living area within the roof of a building, insulation against the heat in summer is also extremely important. To avoid unpleasant overheating in areas directly under roofs, insulation materials with higher volumetric heat storage capacity, greater density and lower thermal conductivity can provide significant benefits. Gutex wood fibre boards are specifically engineered to provide the optimum combination of these properties."

Crosson added that Gutex insulation boards provide superior soundproofing, vapour permeability and moisture regulation over the lifetime of a building. As Gutex external wood fibre boards are impregnated and watertight thanks to their patented tongue and groove system, they may be left exposed for up to three months.

This new publication is now available on **www.ecologicalbuildingsystems.com.** ■

Selsey low energy house first to feature Nilan web control



(above and left) The Selsey low energy house, which features a Nilan Compact P integrated heat pump and heat recovery ventilation system.

Specialist low energy heating & ventilation supplier Nilan UK has recently completed a number of installations of their popular passive house certified heat pump and ventilation units at low energy construction projects in the UK.

The ground-breaking, architecturally striking project in Selsey, West Sussex was another installation of the company's Compact P unit, which features ventilation, space heating & domestic hot water — essentially a plant room in a box. Built by Robbie Walker Construction, the 180 square metre timber frame house was designed by Co-create Consulting in conjunction with Peter Bosson and Caroline King of MPA architects and is the first Compact P unit in the UK to feature web control.

The Compact P, which integrates an air-to-air heat pump with heat recovery ventilation, provides domestic hot water, ventilation, air pre-heating and pre-cooling, coupled in conjunction with the Nilan 75mm radial ductwork system. The timber-clad house also scored an airtightness test result of 1.85 $m^3/hr/m^2$.

Nilan UK managing director Stuart Laughton explained how the web control system works. "We are able to monitor the unit for fault codes, condenser and evaporator temperatures, mean average extract temperature from the dwelling, indoor and external temperatures and the hot water tank. Alarm codes can be re-set and energy usage data downloaded at pre-determined intervals to produce detailed analysis," he said.

Stuart said the technology would be particularly useful on large residential schemes, where it would enable maintenance personnel to see an overview of how Nilan Compact units are performing across an entire development.

Nilan UK also recently completed the installation of Compact Ps for a development of five low energy homes in Hastings. Stuart told Passive House Plus that monitoring showed one of the houses having a total energy bill (for all electricity and heating needs) of just £233 from January to May — not factoring in the feed-in-tariff from solar PV generation, which he said would reduce the net energy spend to about £20 for that period.

For more information see **www.nilanuk.com**. ■

Bow Tie construction seeks builders & site supervisors

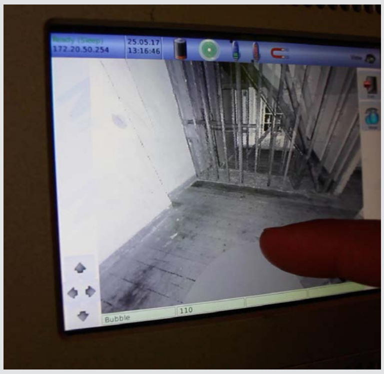
Leading passive and low energy building contractor Bow Tie Construction is looking to recruit site supervisors and builders in the Dorset and Hampshire areas. The company is tendering for a number of projects in these areas and will soon require more builders. Passive house experience and knowledge is a bonus but is not necessary as training will be given. It is essential that applicants have a commitment to building sustainably and to the highest quality standards.

Bow Tie Construction utilises a number of modern technologies, including cloud-based project management, and is particularly seeking workers keen to take advantage of the efficiencies and savings that such technologies offer.

Bow Tie have recently undertaken BIM scanning of an Enerphit refurb project in Kennington in London and intend to use BIM on all future projects.

For company contact details visit **www.bowtieconstruction.co.uk**.

(below) Bow Tie conducting BIM scanning on a recent Enerphit project in London.



Early design crucial for cost-effective MVHR — CVC Direct

CVC Direct, leading designers and installers of mechanical ventilation systems with heat recovery (MVHR), have outlined why proper ventilation design in the early stages of a project is so crucial for an efficient and cost-effective system.

"Very few house designs make any serious provision for accommodating an MVHR unit or associated ducting, so the resultant system can be unnecessarily complicated and costly," said Tim Bartlett of CVC Direct. "People are often surprised how much space an MVHR unit requires or how much ducting is necessary to allow for the quiet distribution of air within a dwelling."

"As a company specialising in MVHR, we regularly see plans for houses with vaulted ceilings, no storage areas and a proliferation of steel beams, none of which help the planning of a sensible ventilation system. Open web joists are wonderful for simplifying the installation of all the services that a modern house requires, but their efficacy is much reduced if they are caged by steel or glulam beams."

Bartlett said that space is required not only for the MVHR unit, but that allowance should also be made for easy connections of ducting, as convoluted duct routes are inefficient.

He continued: "Thought needs to be given to the siting of external vents, particularly the air inlet vent, which should be in a shaded area if possible. Access to an installed MVHR unit should be made as easy as possible otherwise the end user is likely to neglect to clean or change filters."

Bartlett explained that the use of radial ducting systems has become increasingly popular recently as an alternative to rigid trunk and branch systems. These supply or extract air via manifolds to or from each room using individual, non-branching ducts.

"These systems offer great versatility, ease of installation, greater predictability of results and are generally quieter if correctly specified," he said. "The downside is that the manifolds and associated ducting add even more bulk to a system so provision needs to be made for this at an early stage of design."

CVC Direct has also developed a CPD presentation which highlights some of the problem areas in designing and installing ventilation systems, and aims to educate and inform architects and specifiers. ■

(below) A recent CVC Direct MVHR project including Ubbink manifolded radial ducting.

Ecology borrowers move into 'permanently affordable' London homes

The first residents, including a number of Ecology Building Society borrowers, have now moved into brand new homes that are being sold by London Community Land Trust (London CLT) at prices less than half their market value. In a statement, Ecology said it had "pioneered an innovative solution to provide mortgages for the homes that will be permanently affordable".

St Clements in Tower Hamlets, London is a housing development of a former Victorian workhouse which will provide 252 new homes, including 23 affordable homes, for the London CLT.

The construction of the homes follows a long grassroots campaign led by charity Citizens UK. The homes are being sold to local residents who meet certain criteria at a price linked to local earnings. In order to keep the homes permanently affordable, if the homeowners choose to move, they have to reapply the same formula based on average local incomes when they sell.

The scheme challenges the traditional mortgage market reliance on open market value for underwriting, with Ecology developing the bespoke solution that takes account of the homes' "permanent affordability".

Ecology is a leading supporter of the Community Land Trust movement, which offers a mutual and inclusive approach to tackling local housing, and is currently working with a number of CLTs across the UK.

Paul Ellis, chief executive at Ecology Building Society, explained Ecology's approach to supporting the scheme: "Given our long standing commitment to supporting affordable and community-led housing, we were delighted to be able to lead the way on the delivery of an innovative solution providing mortgages on these permanently affordable homes. We'd like to extend our best wishes to all our borrowers as they move into their new homes. We also look forward to working with London CLT again in the future as they build more genuinely affordable homes. Finally, we hope that our approach will now enable other lenders to consider this type of housing." ■

(above) An illustration of St Clements in Tower Hamlets, a pioneering 'permanently affordable' housing scheme.

Passive House Systems offers nationwide airtightness training

LABC-certified airtightness training, now available throughout the UK via Passive House Systems.

Essex-based Passive House Systems Ltd, the UK and Irish distributor of the Gerband airtightness and vapour control system, is still offering places on its LABC-certified airtightness installer training programs, which run throughout the country.

As part of the training, course instructor Jason Healy, Passive House Systems sales manager for UK and Ireland, details the reasons why airtightness in modern buildings is important, and covers topics including design for airtightness, correct product specification and — most crucially — successful product application. The course is aimed at various functions in the construction trade, and particularly those responsible for executing low energy housing projects. Course participants will get to work with Gerband products in various realistic construction scenarios.

"Having been involved in construction air-tightness products and testing since 2007, we are constantly providing solutions to airtightness difficulties which are experienced on-site. Key to this is cost-effectiveness, application speed, and preliminary and final test quality," said Patrick Wycherley of Passive House Systems. "We can also facilitate desk-top assessments and on-site training programs, where real details are discussed and products successfully applied."

For more information see **www.passivehousesystems.co.uk**.

BIPVco supply roof-integrated PV for innovative 'Zero House'

Building integrated solar photovoltaic specialists BIPVco are providing Flextron building integrated photovoltaic modules for the Zero House initiative, an innovative green building project lead by The Endeavour Centre and Ryerson University's Department of Architectural Science in Toronto, Canada.

The house is designed to have net zero energy use, zero carbon footprint and zero toxins. It will be on display at the EDITdx Expo for the Design, Innovation and Technology convention in Toronto on 28 October 2017.

BIPVco's Flextron product is a stand-alone module with a 'peel and stick' capability with integrated solar cells. The product has a 17% cell efficiency, and can be adhered to the approved metal or membrane substrate at the roof manufacturer's factory under controlled conditions.

BIPVco solar integrated roofs use super thin photovoltaic sheets integrated directly onto pre-coated metal and membrane components to create a combined PV roof system that can be installed in the same way as a conventional roof.

For more information see **www.bipvco.com**. ■

(above) An illustration of the Zero House initiative, which BIPVco are aiming to help achieve net zero energy results.

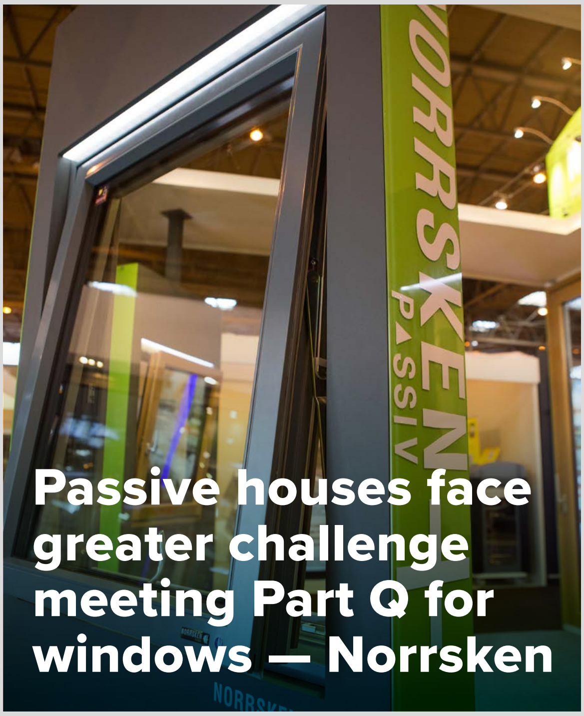
MBC completes passive house in rural Wales

Low energy and passive timber frame manufacturer MBC Timber Frame has recently completed a striking contemporary house in a remote corner of north-west Wales for private clients. The project aimed to meet the passive house standard, though the clients did not seek certification.

The Welsh house features MBC's insulated raft foundation system, which achieves a U-value of 0.105W/m^{2}K, and includes underfloor heating, plus the company's passive standard twin-wall system, which features a continuous unbroken thermal envelope of 300mm of cellulose insulation and achieves a U-value of 0.12 W/m^{2}K, clad externally with both stonework and render board.

The vaulted roofs meanwhile are also insulated with cellulose and achieve a U-value of 0.10 W/m^{2}K. The house scored an airtightness test result of 0.55 air changes per hour, beating the passive house standard of 0.6 — which MBC was contracted to achieve on the project — and the house also features mechanical ventilation with heat recovery (MVHR). MBC Timber Frame has its manufacturing base in Gloucestershire, where it opened a new state-of-the-art factory last year. ■

(below) MBC's latest passive house in north-west Wales, which has just been completed.



Passive houses face greater challenge meeting Part Q for windows — Norrsken

Norrsken, the leading supplier of low energy timber windows and doors, has said recently introduced security standards in Part Q of the building regulations create a potential conflict between security and energy standards for windows.

"One of the challenges we face in specifying high performance windows and doors relates to changes in the building regulations that came in to effect on 1 October 2015," said Alex Alsop of Norrsken.

"The new approved document requires windows and doors on new builds to comply with part Q which is essentially a new security standard. The best way to comply is to have your products tested to PAS 24, which is a series of tests that a door or window is subjected to in order to prove its strength in resisting attack."

"Passive house windows and doors requiring a U-value of 0.8 W/m2K still need to be able to perform to the required security standard, and this crossover can be challenging."

He continued: "A key area in making either a window or door strong enough to resist attack is in the hardware used, and the glazing specification. Both of these areas can reduce performance on the whole unit U-value. The additional material required to strengthen hardware, which is usually a metal product — and hence liable to cause thermal bridges — plus the increase in glass thickness resulting in thinner cavities and a lower thermal performance, can have an impact across a whole project."

Alsop explained that high performance windows typically use triple glazing packages from 44mm to 54mm deep. A typical 48mm package will be comprised of three 4mm glass panes and two 18mm cavities, which contain the insulating gas.

If this glass unit is on the ground floor part of a doorset, Part Q will require it to have laminated glass, which will increase the depth of the external glass pane from 4mm to 8mm. The extra 4mm required is taken directly from the insulated cavity.

"These part Q changes to the building regulations are achievable with passive house or any similar standard of building, but it does push the thermal capabilities of high performance windows even further, giving less margin for error," Alsop said. ■

(above) A Norrsken Passiv window, which is designed with both energy performance and security in mind.

PH+ **HELP DESK**

BUILDING REGS CONFLICT BETWEEN

insulation & fire compartmentation

Both the UK and Ireland's building regulations have failed to reconcile a conflict between thermal and fire safety compartmentation requirements, argues architect and DIT lecturer Simon McGuinness.

I have been struggling to define nearly zero energy building (nZEB) since 2010. This is a serious problem. It takes up to ten years to bed down building regulations and achieve buy-in from all contributors to the notoriously long supply chains involved in the construction industry. Everyone — product manufacturers, suppliers, specifiers, contractors and the trades — needs absolute clarity on the nZEB target.

There is an inherent contradiction in current building regulations in both the UK and Ireland regarding fire spread across compartments and thermal insulation. I speak not of external insulated cladding, but of the party wall condition in adjoining terraced and semi-detached houses.

The Great Fire of London is the origin of controls on fire spread from building to building, a requirement most notable in the architecture of Victorian terraces constructed during the great urban expansion that accompanied the industrial revolution. Incombustible party walls typically extended 375mm above roof level to achieve sufficient fire compartmentation between roofs. With incombustible roof coverings like slate, clay and concrete tile, the compartmentation may be achieved by bedding the roof covering in mortar on the top of the party wall.

More recently, packing any gap between the top of the party wall and the underside of the incombustible roof covering with fire stopping materials became permissible.

UK Approved Document B1 includes guidance on compartmentation at the party wall to roof junction. The technical guidance document for Ireland's Part B includes a three-dimensional representation of the same condition, Diagram 13, which is somewhat more informative.

While the requirement for compartmentation can be achieved by filling any gap between the top of the party wall and the underside of the roof covering with mortar, this will not satisfy the requirements of the building regulations in either jurisdiction regarding surface condensation risk.

In most buildings, Part B will be found to conflict with Part L and/or F at this point. This conflict needs to be addressed by the regulators.

When we overlay the geometry of the rafter and ceiling joist on the elevation of the party wall, we find a direct heat transfer route from inside to outside through masonry of typically no more than 225mm. This means that mould growth is indicated on the party wall at the corner of the room.

Thus, in solving the requirement for compartmentation in Part B, the junction fails the requirement to avoid surface condensation required in Part F (called "surface water activity" in the UK Approved Document F).

With better official guidance, and better enforcement, both requirements can be delivered. In the meantime, I suggest that:

- the party wall be finished 50mm below the top of the rafter with a smooth mortar bed, struck off using some sort of timber gauge;
- a semi-rigid 50mm mineral wool cavity batt then be inserted over the top of the party wall trimmed to fit between the rafters on either side of the party wall;
- the sarking or breather membrane is then installed;
- slating battens are fixed to the top of the rafters and the tiles/slates fitted;
- all slates or tiles above the party wall should be securely nailed and/or clipped in place and the void below them (above the sarking) filled with low density mineral wool quilt at least 500mm wide (nails/clips are critical to compress the quilt). Alternatively, an intumescent expanded foam can be used to seal that void.

For inspection and certification purposes, if the rows of tiles/slates over the party wall are sequentially numbered in chalk by the roofer, a photographic record can be established to demonstrate that the firestopping is in place under each successive tile.

A thermal model taken at right angles to the roof pitch may be required in Ireland to prove that 50mm of mineral wool is sufficiently insulating to ensure the internal temperature of the party wall remains above 15C under standard modelling conventions. If not, then Aerogel quilt may be the only material which is both sufficiently fire resistant and insulating to be used to meet both requirements. (In recent modelling of raised collar roof situations, only Aerogel could deliver the required fRsi).

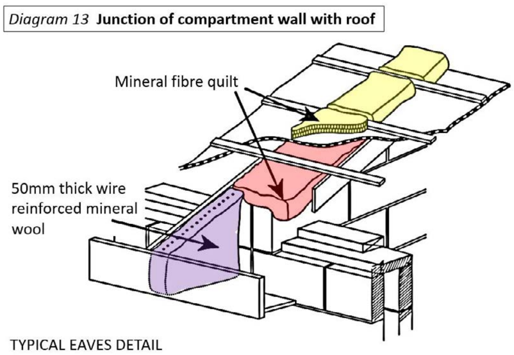
I have recorded many instances over the past 24 months in Ireland where the party wall extends only to the top of the rafter indicating that there is no systematic effort to achieve compliance in relation to surface temperature (fRsi), or fire compartmentation.

The long-awaited report into a fire in a terrace of houses at Millfield Manor, Newbridge, Co Kildare, which saw an entire terrace burn to the ground in less than an hour, may reveal if deficiencies in the construction of the party wall to roof junction was a contributory factor.

Profound and widespread changes to both regulation and enforcement are expected as a result of the Grenfell fire tragedy. ■

> "I have recorded many instances over the past 24 months indicating that there is no systematic effort to achieve compliance.

An edited version of Diagram 13a from TGD B, with tinting and text removed



HAVE A QUESTION YOU WANT TO PUT TO THE HELP DESK?

Email
helpdesk@passivehouseplus.ie

Please note that personal correspondence cannot be entered into.

New Psi value calculator available on: **hi-thermlintels.com**

Available from:
Keystone LINTELS